The Mammoth Cave of Kentucky

REVISED EDITION

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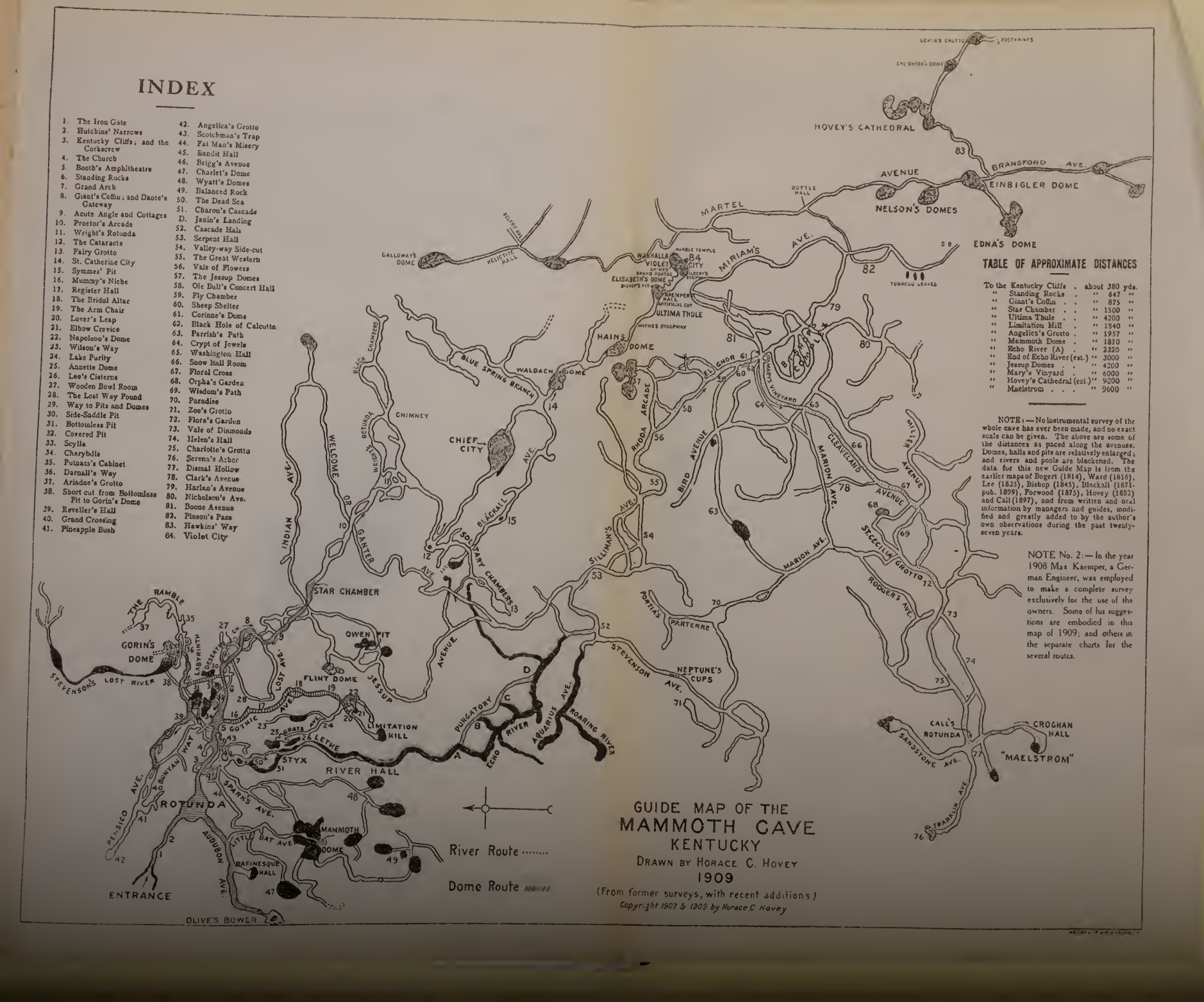
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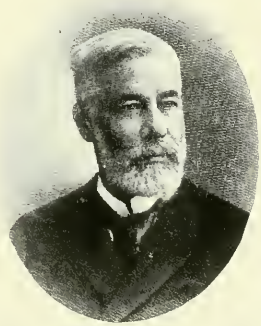
OLIVE'S BOWER
River Route .....
Dome Route
GUIDE MAP OF THE
MAMMOTH CAVE
KENTUCKY
DRAWN BY HORACE C. HOVEY
1909
(From former surveys, with recent additions)
Copyright 1907 & 1909 by Horace C. Hovey
TABLE OF APPROXIMATE DISTANCES
To the Kentucky Cliffs . about 380 yds.
" Standing Rocks . " 647 "
" Giant's Coffin . . " 875 "
" Star Chamber . . " 1500 "
" Ultima Thule . . " 4200 "
" Limitation Hill . " 1540 "
" Angelica's Grotto . " 1957 "
" Mammoth Dome . " 1870 "
" Echo River (A) . " 2320 "
" End of Echo River (est.) " 3000 "
" Jessup Domes . . " 4200 "
" Mary's Vineyard . " 6000 "
" Hovey's Cathedral (est.) " 9200 "
" Maelstrom . . . " 9600 "
NOTE 1.—No instrumental survey of the whole cave has ever been made, and no exact scale can be given. The above are some of the distances as paced along the avenues. Domes, halls and pits are relatively enlarged; and rivers and pools are blackened. The data for this new Guide Map is from the earlier maps of Bogert (1814), Ward (1816), Lee (1835), Bishop (1845), Blackall (1871-pub. 1899), Forwood (1875), Hovey (1882) and Call (1897), and from written and oral information by managers and guides, modified and greatly added to by the author's own observations during the past twenty-seven years.
NOTE No. 2.—In the year 1908 Max Kaemper, a German Engineer, was employed to make a complete survey exclusively for the use of the owners. Some of his suggestions are embodied in this map of 1909; and others in the separate charts for the several routes.

Mammoth Cave
OF KENTUCKY

(Hovey and Call)

WITH AN ACCOUNT OF COLOSSAL CAVERN

REVISED EDITION



By HORACE CARTER HOVEY, D. D., F. G. S. A.

1912

With Historical Notes. Scenic Accounts. Descriptive and Scientific Matters of Interest to Visitors, based upon new and original explorations.

LOUISVILLE
JOHN P. MORTON & COMPANY
INCORPORATED

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PREFACE TO REVISED EDITION

In 1897 two cave-hunters, Horace Carter Hovey and Richard Ellsworth Call, at first separately then jointly, prepared a manual of the Mammoth Cave. Both of them had made frequent and prolonged visits to the Cave, and were able to say that they had personally seen every part of it then known. They had previously written articles for popular and scientific periodicals, and their membership in scientific societies in this and other lands aided their research. Originally their work was of composite authorship, in the sense that any chapter written by one would be revised by the other. Their aim was to give the latest and most exact word as to cavern history and scenery, heights, depths, distances, and magnitudes. Facts not for the first time found here in print were compiled from authentic sources with acknowledgments.

During the fourteen years that have elapsed since then changes and discoveries have been made that demanded a revision of the original manual, and by mutual agreement this task fell to the lot of the senior author. Numerous alterations have been made in the text, subject-matter has been rearranged, and much new material has been added. Throughout this revision it has been my desire to give ample credit to my former co-laborer, though it has not been deemed essential to give by name the exact authorship of the several chapters, further than by means of the preliminary Synopsis. Many of the drawings and photographs of cave fauna were prepared by or for Dr. Call, though for those of the blind fish we are indebted to Dr. Eigenmann and the courtesy

of the Carnegie Institution. Thanks are due to Messrs. Albert C. Janin and Henry C. Ganter for the use of copyrighted cuts (mainly by the late Ben Hains), as well as for personal attentions. Renewed recognition is given to the officials of the Louisville & Nashville Railroad for transportation and other facilities accorded in the earlier and the later work done in preparing this volume.

The general Guide-Map of the Cave, made by me after consulting former maps, and with certain corrections suggested by Mr. Max Kaemper, brings Cave cartography down to the present time. As the Cave is now exhibited by four routes, instead of by two, this has been indicated, as far as practicable, by textual changes and foot-notes; and it is made still more clear by the special charts of these routes.

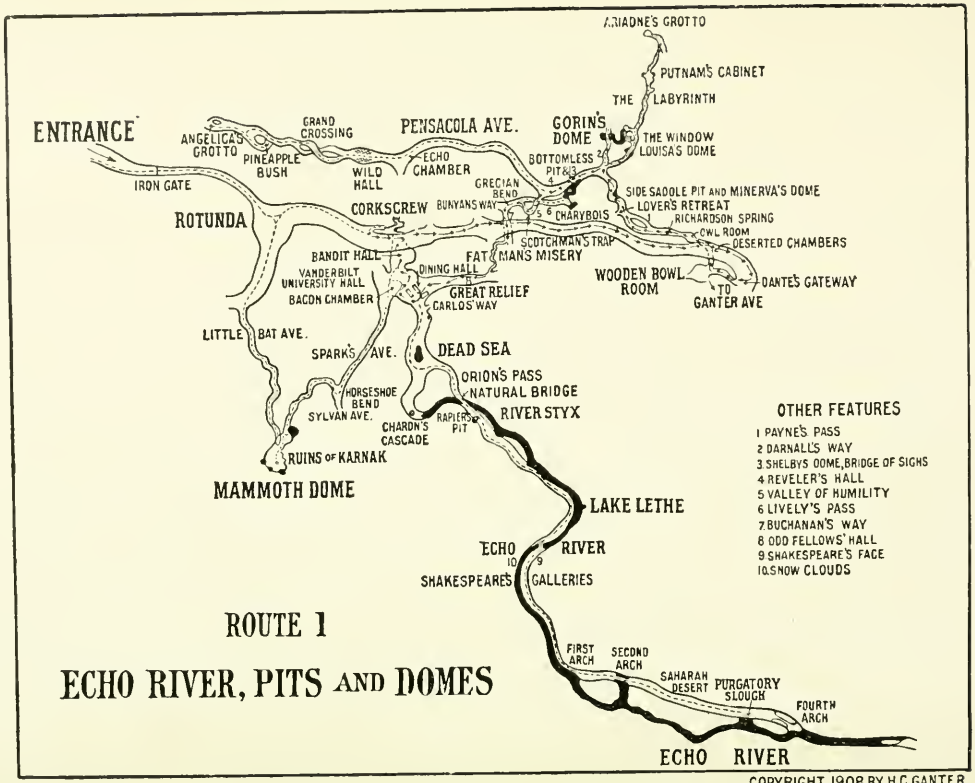
Any one wishing a less expensive Manual, prepared expressly for the guidance of visitors over the regulation routes, is referred to my small Handbook, published by John P. Morton & Company. For terms of exhibition and hotel rates, apply to the Manager of the Mammoth Cave, Kentucky.

HORACE CARTER HOVEY.

Newburyport, Mass.

SYNOPSIS

1. General Map; and Route Charts. (Hovey.)
2. The Cavern Region of Kentucky, and Cave-Making. (Hovey.)
3. Historical Sketch and Environment. (Hovey and Call.)
4. The Route of Pits and Domes. (Call.)
5. The Main Cave Route; to Chief City and Violet City. (Hovey.)
6. The River Route, to the Maelstrom and Hovey's Cathedral. (Hovey.)
7. The Natural History of the Cave; its Fauna and Flora. (Call.)
8. Blind Animals; their Environment and Devolution. (Hovey.)
9. The Colossal Cavern. (Hovey.)



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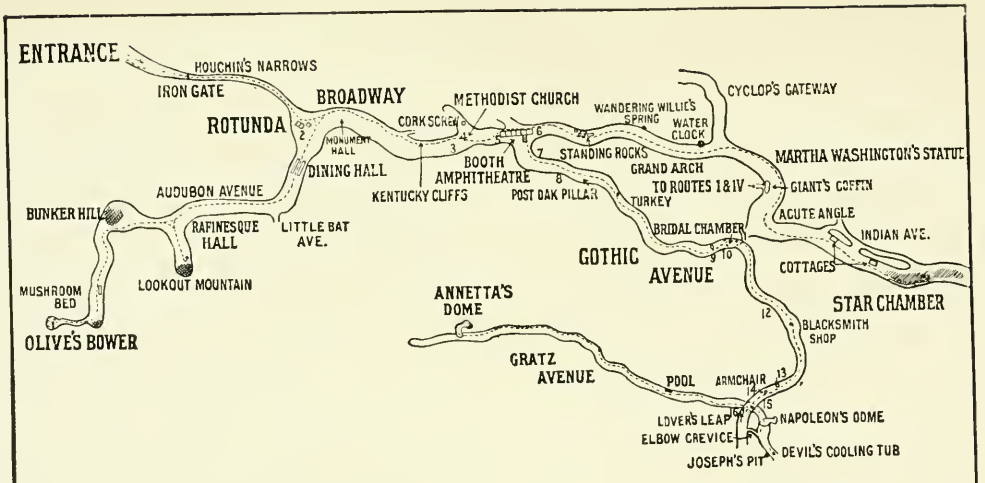

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2. FIRST SALTPETER VATS.
3. PIPE LINES
4. TRACKS OF OXEN AND CARTS
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6. HEAPS OF LIXIVIATED EARTH

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14. LOADED CAMEL
15. ELEPHANTS' HEADS
16. PICTURE FRAME

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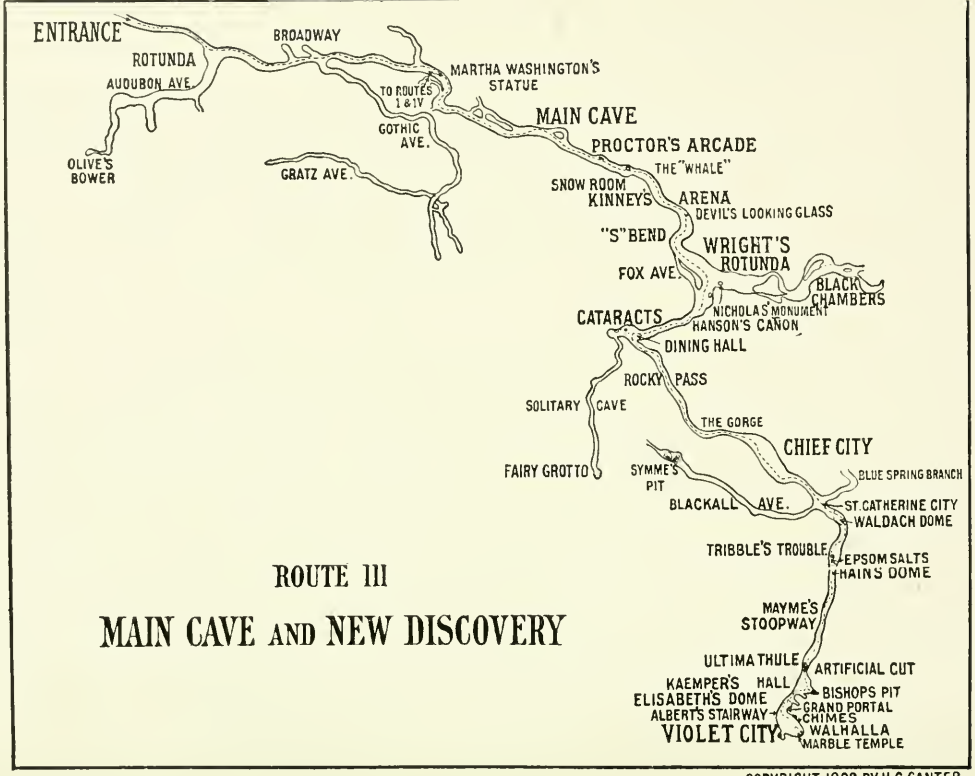

ROUTE 111

MAIN CAVE AND NEW DISCOVERY

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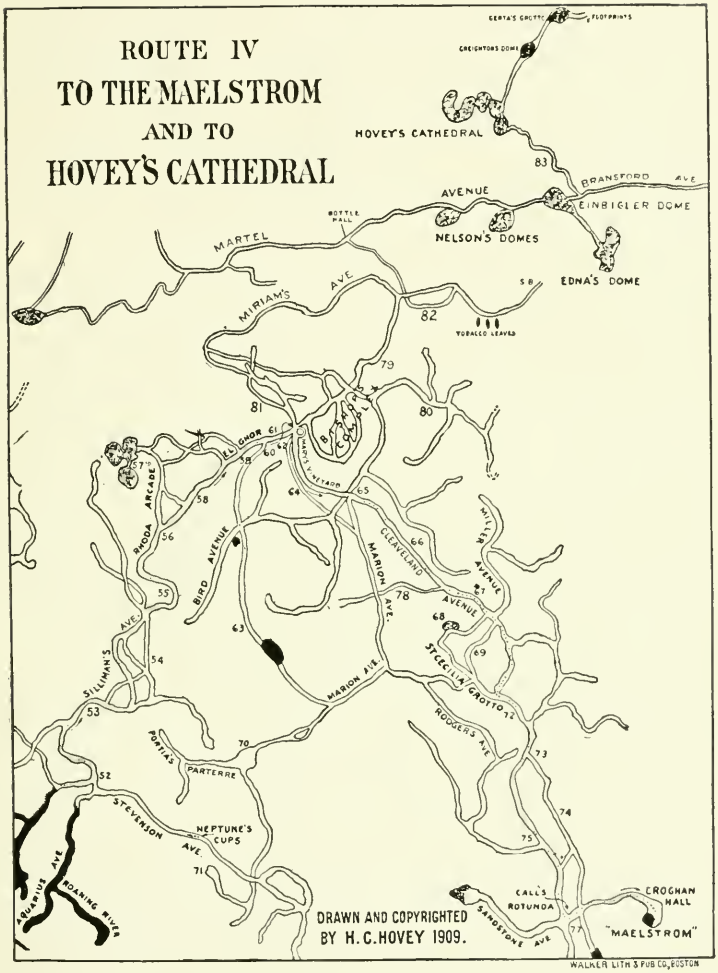
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"MAELSTROM"
ARIADNE AVE.
ROARING RIVER
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THE CAVERN REGION OF KENTUCKY AND CAVE MAKING

LARGE caverns are limited to regions favorable to the process of cave-making. Kentucky is peculiarly such a region. Along rocky sea-coasts grottoes are numerous and often beautiful. But the mighty billows that carve the granite into natural tunnels, or spouting horns, or fantastic arches, also break down their own products, and transform grottoes into chasms, embayments, or straits. This destructive agency has been so vigorously active along the Atlantic coast that not a cavern can be found, from the Bay of Fundy to the Gulf of Mexico, deep enough to exclude the daylight. With ice caves, and those formed in lava-beds, or among coral islands, and in granitic regions, we need not here concern ourselves.

Limestone regions vary according to their exemption from or exposure to mountain-making forces. The limestones of Virginia, for instance, have been upheaved and shaken by orogenic action until they are cracked and fissured by seams running in every direction. These were easily enlarged by the action of water, and were thus developed into countless grottoes, some of which have gained a world-wide celebrity. But the fractured condition of the rocks limited the process of cave-making; and in size the Virginia caves are insignificant, compared with the enormous excavations found in the homogeneous and nearly undisturbed limestone regions of Kentucky and other States of the central West.

Then, again, the conditions of the country rock vary as we descend the valley of the Ohio. About Cincinnati and Covington the Lower Silurian limestones are

presented in thin, fragile strata, with variable layers of shale between; and in these it would be almost impossible for even small grottoes to grow. But when this terrane meets the Upper Silurian, as at Madison, Indiana, the massive upper ledges resist decomposition, while the underlying softer strata are easily eroded; and the result is seen in some of the most picturesque grottoes in the world. Rising in the geological horizon while descending the valley, we enter the most extensive cave region on the globe. The Ohio River transects this territory in such a manner that three fourths of it lies in Kentucky, while the remaining fourth is divided between Indiana and Tennessee. In Indiana is the wonderful Wyandot Cave, and in Tennessee the formidable Nicajack; which are worthy rivals of Kentucky's greatest cavern.

The main line of the Louisville & Nashville Railroad runs through the region in which Mammoth Cave is located. And as we ride swiftly and comfortably along we can observe from the cars the more conspicuous results of the complex erosive process by which the landscape has been wrought into its present features.

Imagine a vast plain, which in its entirety covers quite eight thousand square miles, and that plain, during successive ages, slowly and gently uplifted, as a whole, by geological agencies. Extensive erosion necessarily would ensue. For, previous to this uplifting, this part of the continent was submerged; but since the Carboniferous period the region has been dry land. Unlike the areas to the remote West and South, there are here no Cretaceous nor Tertiary rocks. The hills are all Carboniferous; though in many places, as in the vicinity of Louisville, these eminences have been worn away, and

the underlying Devonian and Silurian now form the country rock.

Meanwhile the falling rains have run over the slightly tilted limestone rocks, wearing their surface into furrows and undermining the harder ledges. Additional to this mechanical agency chemical forces have been at work. From the air and the soil the rain-water gathers into itself carbonic acid (carbon dioxide) which attacks the limestone, dissolves it slowly or rapidly, as the case may be; after which the water runs away with its mineral burden. The region once level now becomes undulating; the surface waters find, or make, underground channels, and finally the region is honey-combed with caverns. Where less soluble rocks occur, or form the surface, the process of erosion is less rapid. Hills are thus formed, their very tops refusing to yield to solution. The environs become lower, and finally conical masses remain, testifying by their geologic structure to the processes that have been at work.

The problem is complicated, so far as the region around the Mammoth Cave is concerned, by the fact that the compact Chester Sandstone overlies the St. Louis Limestone, which is here largely oölitic. The sandstone yields slowly to the mechanical action of the running water, but resists its chemical action; while the limestone yields to both these agencies. It thus happens that there are visible thousands of "knobs" and myriads of "sink-holes." Knobs are eminences, sometimes several hundred feet high, and frequently perfect pyramids, left by the erosion of the weaker rocks, the original strata being diminished horizontally, but undisturbed in position, even to the apex of the pyramidal peak. The sink-holes, on the other hand,

are usually oval depressions, of every conceivable size and of variant depths, without inlet or outlet, except through funnels which communicate with subterranean passages. These pits were, in former times, and sometimes still are, natural animal-traps, into which has fallen many a wild denizen of the forest. In order to save domestic animals from a similar catastrophe numerous sink-holes have been artificially plugged, thus transforming them into deep pools. So extensive has been the undermining by the process now described, that one may travel on horseback all day, through certain parts of Kentucky, without crossing a single running surface stream; all the rain-water that falls being carried down through the sink-holes into caverns below, where are the gathering-beds that feed the few large open streams of the region, of which the Green River is an example.

It is reported that there are four thousand sink-holes and five hundred known caverns in Edmonson County alone. The Mammoth Cave Railway, that leads from Glasgow Junction directly to the cave, passes a number of them. The largest sink-hole known is the Eden Valley, along whose margin the road runs. This charming valley is adorned by fertile farms, and occasional ponds that mirror the passing clouds, and it is flanked by the virgin forest; but after all it is a true sink-hole, without inlet or outlet. Its area is certainly not less than two thousand acres, and this enormous depression must have been made by the falling in of a series of great caverns.

The reader will not expect us in this Manual, which is meant to describe a single famous cavern, to offer a catalogue of the other known caverns of the county.

Some of these, like the Diamond, the Grand Crystal, Proctor's, and the recently opened Colossal Cavern, have gained more than a local celebrity. Another large cavern, the Salt Cave, belongs to the Mammoth Cave estate, and has interest for scientific men on account of its prehistoric relics. It is now very difficult of access; and being absolutely dry, the explorer needs to carry his own water supply. Hence it is rarely visited.

The White Cave belongs to the same estate, and is well worth visiting. It gets its name from the brilliant whiteness of its stalactitic formations. It is really a branch of the Mammoth Cave, being connected with it by a passage, now occluded, leading to Klett's Dome and the Mammoth Dome, of which the former is a portion, separated therefrom by the thin floor at the end of Little Bat Avenue, through which Crevice Pit leads —connecting thus the two domes that are practically and geologically identical.

The entrance to the White Cave is guarded by an iron gate, beyond which is an oval chamber, irregular in outline, beneath whose low, flat roof we proceed to the second chamber. Here is exhibited a splendid piece of stalactitic drapery, called the Frozen Cascade. It is fretted and folded in a thousand fantastic forms, and well deserves its name. The resemblance of this mass of onyx to the gigantic columns formed in winter around great waterfalls, such as Niagara, is indeed striking. The roof is covered with pendants, from the largest stalactites down to those as small as a quill; each one of which is hollow, and from whose tips hang tremulous drops of water sparkling like diamonds. The floor is intersected with shallow, crooked channels, in which

run transparent rills. A stately shaft, named Humboldt's Column, appears to support the low arch.

In the third chamber are huge blocks of limestone cemented together and encumbering the floor. And around all is kindly drawn a wide veil of the purest alabaster. Attempts have been made to break through this mighty curtain, with the hope of finding a passage into the Mammoth Cave. With the same wish certain deep pits in the vicinity have been thoroughly explored, but thus far in vain.

Some ninety years ago Mr. J. D. Clifford, a Kentuckian, exhumed from the floor of the White Cave certain bones, that, after passing through several hands, finally came into the possession of the Academy of Natural Sciences, at Philadelphia. It has been stated that among them were the remains of bisons, stags, a bear, a megalonyx, and also a human skeleton. This remarkable statement is open to serious question, beyond the megalonyx bones; and it is mentioned here merely because some degree of paleontologic importance has been attached to the story.*

Dixon's Cave, also belonging to the same estate, is supposed to have been, at some remote prehistoric time, the original mouth of the Mammoth Cave. However this may be, the cave is well worth visiting for its own sake. Its mouth is a yawning gulf, somewhat larger than that by which one enters Mammoth Cave. In its present condition it is obstructed by fallen

*See a reference to the Megalonyx of the White Cave, Kentucky, by Doctor Richard Harlan, American Journal of Geology, Vol. 1, page 76; and a more full account of the same on page 171, by Professor William Cooper, who distinguishes it from the specimen found at Big-Bone Lick, Kentucky, and in the Big-Bone Cave, in White County, Tennessee. See also Transactions of the Geological Society of Pennsylvania, August, 1884, pp. 67-70 and pp. 144-146.—H. C. H.

forest trees, over or under whose trunks and sprawling branches we must climb or creep. We are rewarded by finding ourselves in the mightiest subterranean hall yet discovered. The cavern is a single immense temple with one eternal arch of limestone. By our measurement it is fifteen hundred feet long, from sixty to eighty feet wide, and from eighty to one hundred and twenty-five feet high. It gradually curves from southeast to due south; and the dimensions are quite uniform throughout. The roof is decorated here and there by numerous stalactites, none of them very large; and other parts of it are blackened by myriads of bats, especially in winter, clinging together like swarms of bees. Every foot of the floor was searched and overturned long ago by the industrious miners, who carried the niter-bearing earth outside to the vats and boiling-tubs whose ruins are yet visible. The miners left the rocky fragments within the cavern piled in what might be described as transverse stony billows, of which we counted eighteen; each wave being forty feet through at the base, and rising thirty or forty feet above the true floor. At the extreme end the mass of earth and rock does not seem to have been disturbed. Over this we can climb to the very roof, amid whose nooks we sought in vain for access to Mammoth Cave. Doubtless by suitable excavation the desired connection might be made. Igniting a series of Bengal lights simultaneously, we were able to take in at a glance the dimensions of this enormous hall of Titanic magnitude.

Green River is the only openly running stream in the immediate region, and its waters are wholly fed from subterranean reservoirs. Its bluffs are gashed here and there by rifts, or wide arches, from some of

which issue streams that serve as modes of exit for underground waters. Were it practicable to enter them, we might climb through a series of rocky galleries, till at last we emerged in some one of those oval valleys already described as sink-holes. The usual mode of entrance to caverns, however, is at some place where the roof has broken through, and whose rocky fragments, partly filling the subterranean dome, serve as convenient stepping-stones down into darkness.

Such a break is the present entrance to the Mammoth Cave. It is one hundred and eighteen feet below the crest of the bluff, one hundred and ninety-four feet above the level of Green River, and seven hundred and thirty-five feet above the level of the sea. The limestone bed measures three hundred and twenty-eight feet in thickness, from its upper limit, where it is in contact with the sandstone, down to the drainage level of the cave, and doubtless extends below many feet further. The sandstone, which is Subcarboniferous, with occasional layers of conglomerate, rises at the surface in irregular elevations. This geological fact accounts for the vast area of the cavern, and also for the paucity of its stalactitic decoration compared with other caverns; as for instance with the adjacent White Cave, from above which the sandstone has been entirely stripped away.

The British Association for the Advancement of Science, and also the Smithsonian Institution of this country, took much interest a few years ago in a series of observations for determining the mean temperature of the crust of the earth. They justly reasoned that by ascertaining the temperature of the immense and nearly stationary body of air confined in Mammoth Cave

Photographed for H. C. Hovey.

they would approximate to the temperature of the crust of the earth for the same latitude. Accordingly they requested the senior author of this Manual to make a series of observations, which he did with the utmost care in 1881, not only here but in other caverns, using for the purpose verified thermometers furnished to him expressly by the Kew and the Winchester Observatories. The final result of more than a hundred experiments was that the mean temperature of Mammoth Cave, and of other caverns in the same latitude, is about fifty-four degrees Fahrenheit. The extremes of external cold or heat may have to be allowed for. Every summer visitor notices the strong current of air flowing out from the mouth of Mammoth Cave, and that at times amounts to a gale preventing our carrying lighted lamps into the entrance. The cool air wells up like an invisible fountain, and flows down like a stream toward Green River. Into this aerial stream we step, we wade knee-deep, we are finally immersed as we enter the great cavern.

But let us pause for a few moments longer, in order to consider the natural history of this vast excavation. First or last every intelligent visitor is sure to ask, "How did it all come about? What was the process of cave-making?" These excusable inquiries might as well be met at the outset, although in doing so we shall have to anticipate to some degree the phenomena to be brought to notice later on.

As already remarked, the entrance to the cave is at a place where the roof has broken through. The term "tumble-down" is used regarding such localities inside the cavern. There are many of them; particularly at the end of Rafinesque Hall, at the end of Gratz Avenue,

at Sandstone Dome, in Violet City, and in a short hall at the left of the Cataracts. All these tumble-downs are where the overlying sandstone strata and the underlying strata of thin limestone have been worn away, leaving the weakened roof to fall in, carrying along rocky fragments, and also a mass of clay and soil, whereby the passage-ways are occluded. Besides blocking up the galleries where they occur, they also betray the fact that the surface can not be far away.

One of the most curious and instructive of these roof-breaks is just to the left of the Cataracts, where what is known as the Main Cave abruptly terminates by a crushing down of the superincumbent strata singularly bent and folded in a direction the reverse of the main arch. Doctor Call, who first attracted attention to this mimic syncline, regards it as due to slight orographic movements by which the rocks were cracked and fissured till the thin limestone plates were bent by the great weight of the sandstone strata overhead.

Above the Cataracts is a sink now determining the flow of the waters that enter from the surface at some distance from the crushed limestone reversed arch, or synclinal, which are worn away from it to the right, thus steadily, though slowly, excavating a tunnel that will ultimately become a narrow avenue under the surrounding rocks.

Pits and domes play their part in cave-making. Dawkins and Shaler regard them as tubes cut down by whirling water using sand and pebbles as teeth for cutting through from the highest to the lowest level. We are convinced that this theory is untenable. Were it correct the pits should be wider at the top than at the bottom. But, with rare exceptions, as for instance in the

Edna Dome, it is otherwise. As a rule, a small crevice, four or five feet wide, expands into a pit that may be several hundred feet wide. In cave terms this is a "pit" if seen from above, and a "dome" if seen from below. In many such shafts there is water; but it flows along the floor or trickles down the sides, with not a sign of its having ever been "whirled about with pebbles for teeth," as asserted by Shaler. The grooving is invariably vertical, with no marks of drilling or grinding. Doctor Call and I examined many small domes that were formed on exactly the same plan as the larger ones; and in every instance their apex was solid, except for a tiny crevice through which the water gently flowed. In most of them not a pebble or grain of sand was visible.

We were impressed by the evidences of solution greeting us on every hand. Not only amid the pits and domes, but in the arid avenues and tortuous channels, signs of aqueous erosion abounded. The solvent agency of water was evinced by the Pigeon-holes, the Mummy's Niche, the Fat Man's Misery, as well as by the rounded and worn bosses, and the smoothed walls and curves of the spacious halls.

With such signs in sight the genesis of Mammoth Cave is quite simple and easy of explanation. It is within the St. Louis Limestone and underneath the Chester Sandstone; both being members of the Subcarboniferous period. Between these formations is often found a layer of conglomerate, whence come the silicious pebbles often found on the floor of the cavern Here and there, as in the bed of Mystic River, appear masses of chert or flintlike rock. The elevation from the low-water level of Green River to the sandstone outcrop in the bluff is about three hundred and twenty-five feet; from which

we infer that the lowest level of the cavern is that distance from the superincumbent sandstone. We have not found any hall or dome that measured more than one hundred and sixty feet, and doubt if any exists as high as two hundred feet. The tendency has been to exaggerate cave heights as well as cave distances.

Existing avenues began with small fissures where the rock had been fractured, and the gently flowing or wildly rushing waters have wrought the narrow or broader passage-ways. Everywhere are signs of erosion and solution. We doubt if the ancient streams in the cavern were ever larger than they are now at high water. Some of the so-called sand-beds are in reality only the result of disintegration of oölitic limestone. On the other hand the true sand when found is as sharp as when it fell from the sandstone capping the limestone overhead. Trickling and evaporating lime-water explains the forming of stalactites and stalagmites; while the crystals of gypsum, calcite, and various salts, all tell their story of subterranean chemistry. "In brief," as Doctor Call remarks, "the visitor is to look at the great work of excavation of the Mammoth Cave as solely a *problem in solution.*" The limestone is usually soft enough to be scratched by a knife, and in certain places it readily disintegrates, its egglike particles being separated by the solvent action of the water; and as already observed some of the avenues have a floor entirely made up of fine oölitic sand.

At the end of Darnall's Way where it opens upon the summit of Gorin's Dome, masses of limestone that seemed solid and firm yielded like putty under the hand, or crumbled at a touch. This was indeed such an element of danger that Mr. Gaunter had his men go

with sledge-hammers and crowbars and break down or pry off the jutting edges till rock was reached sufficiently solid to support the timbers of the bridge he had them build across the chasm.

It has been customary to explain the great fallen masses, like the Standing Rocks, the Giant's Coffin, the Whale, and the huge blocks visible in the Corkscrew, and elsewhere, as caused by earthquakes. Of course it is possible, though we find few signs of seismic action anywhere. It is more probable that these masses fell by their own weight after having been loosened by solution along the joints caused by early continental uplifting.

The subterranean rivers, after all, are the great cave-makers. One who sees them at their lowest stage in summer and floats over them at his leisure, amusing himself by their echoes, can have no idea of their tremendous volume and force in winter or early spring. There are times when the Dead Sea, Styx, Lake Lethe, Echo River and the Roaring River combine into a swollen stream fully two miles long, and how much further into inaccessible depths nobody knows, and with a maximum depth of one hundred feet. Moreover this flood has a strong current making navigation dangerous. Rising, falling, sweeping under overhanging ledges, these waters hollow out long horizontal passage-ways, sway to and fro like liquid battering-rams, hammer down weak walls, and undermine arches, thus making, during many ages, those successive tiers, or galleries, for which the cave is noted. Thus the mechanical force and action of running water must be reckoned into the account, as well as the more silent energy of simple solution. As the process goes on, the cave cuts down from high levels to lower

ones, thus leaving the upper galleries dry as tinder, of which Gothic Avenue is a conspicuous example.

On the other hand a filling-up process also goes on. Standing water deposits nitrous earth and various mineral substances. Water trickling from crevices in the roof slowly evaporates, thus creating stalactites and stalagmites, by which the passages are finally occluded, as is the case with the avenue beyond Olive's Bower. But it will take countless ages to obliterate the immense cavity from whose ramifications it is estimated that millions of cubic yards of limestone have been removed by the chemical and mechanical action of the waters that drip, trickle, flow or rush through the multiplied openings of this subterranean realm which we are about to explore.

NOTE.—A word further as to air currents, which are sometimes quite violent. The theory that the air rushes into the cave in winter and out in summer must now be modified. Mr. A. M. Banta made observations with an anemometer in the winter of 1903, and says, "The air currents were surprisingly fitful." The air would run in for a few minutes and then flow out again. He recorded the inward rates per hour in February as varying from 56,556 feet to 77,396 feet. Eigenmann, who made observations in November, reports the ingoing rates as varying from 7,800 feet per hour to a maximum of 55,830 feet. Again he says: "I have been at the entrance to Mammoth Cave when the internal and external pressures were so equalized that the anemometer would show ingoing and outgoing currents alternating irregularly every few minutes." I find no record of the force of outgoing currents in summer. Very decided air currents were observed by me in Gorin's Dome and the Mammoth Dome, seeming to prove an outside opening.—H. C. H.

HISTORICAL SKETCH AND ENVIRONMENT

AS many as twenty-eight limestone caverns were known in Kentucky by the year 1800, beside many "rock-houses." From these a certain Mr. Fowler is said to have obtained "one hundred thousand pounds of niter." It is stated, in the early accounts of these localities, that solid masses of saltpeter were found "weighing from one hundred to sixteen hundred pounds." Byrem Lawrence, in his Geology of the Western States, published in 1843, corrects a popular error by saying of these deposits: "False saltpeter is found in many caves, particularly in the Mammoth Cave. It is but a nitrate of lime, and has to be changed to the nitrate of potash by leaching it through wood ashes." Doctor Samuel Brown, of Lexington, made a journey of a thousand miles on horseback, in the year 1806, in order to lay before the American Philosophical Society at Philadelphia the facts concerning these resources, which, he declared, would be especially precious in case of warfare with any foreign power. He enters into details as to the manufacture of saltpeter, but does not mention Mammoth Cave. The records at Bowling Green designate that cave as a corner of a section of land in 1797; which antedates the statement by Bayard Taylor that it was found in 1802, and of Frank Gorin that it was first entered by Houchins in 1809. The fact that it was rich in nitrous earth led to its purchase by a Mr. McLean, in 1811, who bought the cave and two hundred acres of

land about its mouth, paying for it the sum of forty dollars. McLean soon sold it to Mr. Gatewood, who, in turn, sold it to Messrs. Gratz and Wilkins, whose agent, Mr. Archibald Miller, made a fortune for them from it during the War of 1812. The remains of their saltpeter works are still to be seen at certain places within the cave.

Rebecca Gratz, daughter of the senior member of this firm, was a beautiful Jewess, and a friend of Washington Irving, who related her romantic story to Sir Walter Scott in 1817. Shortly afterward "Ivanhoe" appeared, in 1819. Scott sent a first copy to Irving, asking, "How do you like your 'Rebecca'? Does the Rebecca I have pictured [in Ivanhoe] compare well with the pattern given by you?" Miss Gratz was born in 1781 and died in 1869, at Philadelphia.

A few words are in place regarding the early crude manufacture of one of the essential ingredients of gunpowder. The "miners" were mainly negroes, who gathered the "peter-dirt," as it was familiarly called, using ox-carts for bringing it from the more accessible avenues, and carrying it in sacks from remoter rooms. The soil was leached in vats within the cave; whence the solution was pumped out to open-air boilers. The concentrated liquor was next run through hoppers filled with wood ashes, boiled a second time, and cooled in wooden troughs. Then the crystals of potassium nitrate which formed were taken out and packed for transportation by the most primitive methods to the seaboard. The yield was, on an average, about four pounds of the calcium nitrate to the bushel of "peter-dirt," and Mr. Miller reported to his employers that, from the Mammoth Cave alone, they could "supply the whole

population of the globe with saltpeter." Emphasis should be laid on the fact, not mentioned in any history of the United States, that our War with Great Britain, in 1812, would have ended in failure on our side had it not been for the resources so abundantly furnished by American caverns for the home manufacture of saltpeter at a time when by a general embargo we were wholly cut off from foreign sources of supply.

Gratz and Wilkins, in 1816, disposed of the cave, together with about sixteen hundred acres of land, to Mr. James Moore, a Philadelphia merchant, who was ruined, it is averred, by his complications with Burr and Blennerhassett. Thereupon the property passed once more, for a time, into the hands of Mr. Gatewood, who made it a place of exhibition to the public.

In 1837 the estate was purchased by Mr. Frank Gorin, who employed Moore and Miller as his agents, and Stephen Bishop and Matt Bransford as guides. Then began the era of discoveries. Explorations were pushed to such a degree that the wonders of the cave attracted attention, not only throughout America, but also in Europe. Among the immediate causes for such active exploration was the fact that Mr. C. F. Harvey, Mr. Gorin's nephew, was lost in the cave for thirty-nine hours. And among the results was the fact that Doctor John Croghan, a young physician of Louisville, was repeatedly asked, during his travels abroad, about the marvels of Mammoth Cave. It mortified him to own that he could give no information. Accordingly, on his return, he visited the locality, and was so charmed with it that he bought it of Mr. Gorin, on October 8, 1839, for $10,000, and expended large sums in its development. At his death, in 1845, he devised the estate to

his eleven nephews and nieces, the sons and daughters of Colonel George Croghan, Mr. William Croghan, and General T. S. Jessup; of these only three now survive. At their decease the property, which includes some two thousand acres, must be sold, and the proceeds divided equally among the heirs of the legatees.*

Among the agents who have exhibited the cave may be mentioned Messrs. Archibald, James and William Miller, L. J. Proctor, W. Owsley, D. L. Graves, Francis Klett, W. C. Comstock, H. C. Ganter, and L. F. Charlet. Of the guides, Stephen Bishop and Matt Bransford merit special distinction. Though slaves they became learned in their line of research, and won world-wide celebrity for scientific knowledge of subterranean matters. Both are now dead; as is also Nicholas Bransford, the brother of Matt, and William Garvin. The list of recent guides includes William Bransford, Edward Bishop, Edward Hawkins, Joshua Wilson, Robert Lively, and John Nelson. Others, both white men and negroes, are at hand for emergencies. None but responsible guides are employed, and visitors are required to respect their authority.

A short walk from the railway train brings us to the Mammoth Cave Hotel, which is an interesting case of evolution from a log cabin. The original cabin still stands, just as it did in the days of the saltpeter miners, only being now weather-boarded the logs are hidden from observation. Other cabins were added, at a later day, standing in a long row; and a central cabin was built, with a wide hall between two parlors. In process of time all these isolated cabins were joined together as

*A bill for the expropriation of the estate as a national park was introduced in U. S. Congress by Hon. R. Y. Thomas, M. C., January 17, 1911.

one structure, with wide verandas and six hundred feet of covered portico. A spacious frame house was erected in front, with offices, dining-hall, assembly-room, and other conveniences. The tall, white pillars of the long colonnade, between which one looks out on a grove of oaks and cedars, the ample lawn, the extensive garden, together with the rustic surroundings, make the place a delightful resort for those who do not demand too many city privileges in the heart of a primitive forest.

The natural beauty of the pathway from the hotel to the mouth of the cavern always awakens the interest of every nature-loving visitor; whether it be traversed in the dewy morning, at sultry noon, or by fascinating moonlight. The rough pathway is sufficiently smoothed to permit us to notice our surroundings. Tall sycamores, chestnuts, poplars—the tulip tree of the region—gnarled and knotted oaks festooned with giant vines, clumps of pawpaw, or of spice-wood, with occasional groups of the Judas-tree, and an undergrowth of smaller bushes, moss-beds and fairy-like ferns, amid which are sprinkled myriads of brilliant fungi, conspire to make a landscape of singular beauty and botanical richness. However gay and merry the party may be, the freshness and loveliness of the pathway always excite attention and become a subject of conversation. At a point about three hundred yards from the hotel the path strikes a wagon-road that leads down to Green River and the steamboat landing. Paths diverge to the Upper and Lower Big Springs, places that have long been regarded as exits for the subterranean rivers. But when one considers the great volume of water pent up within the rocks, and the rapidity with which it often

rises and falls, it is evident that, although these deep and limpid springs may be connected with Echo River and other cave streams, they can not be their main outlet.

Visitors usually defer their ramble to Green River, and cross the wagon-road directly to the entrance of the cave. In former times a hotel stood near the great opening that now confronts us. But the building was destroyed by fire many years ago, and only the scarred trees near by prove that it ever existed. The opening to the subterranean world which we are to visit is on our right, as we approach, and its actual dimensions are usually underestimated at first sight. But it is indeed a noble vestibule, and our impressions of its size undergo revision as we descend the stairway of limestone slabs, leading beyond the waterfall that leaps down on our left from a ledge garlanded with ferns and the greenest of liverworts, and conducting us amid the gloomy shadows where the daylight slowly dies into utter darkness. A singular fact about this mysterious cascade is that it emerges from a rift in the rocks, gleams for a moment in the sunlight as it measures its fall from the arch to the floor, and then instantly sinks to begin anew its wanderings through realms of eternal night in the nether world.

This is the only entrance to Mammoth Cave; or if there are other entrances the fact has never been made known. Into this opening, smaller then than now, went that legendary bear, with the hunter Hutchins after him, which, by an accident of the chase, gave to the world of letters and of science this greatest of caverns. Since those days the fallen trees and rocky debris have been patiently removed by men skilled in

The Entrance—Looking Down.

underground toil, and the rougher places with uncertain bottom have been smoothed and filled, until the veteran Nimrod would not now recognize the place which he is said by Mr. Frank Gorin to have been the first of all mankind to see and imperfectly explore.

Certain hours are fixed for entering the Cave, from which it is not usual to depart. Four routes are mapped out, the uniform charge for each being two dollars. For terms for the season, or for large parties, or indeed for anything special, application should be made to the Mammoth Cave Manager. Cave suits are to let, and proper methods of illumination are provided by the guides.

As this Manual is meant for the leisurely perusal of the general reader, the revising editor has thought it necessary to recast only in part the descriptions originally written by the joint authors, at a time when the method of exhibiting the Cave was by two principal routes and several special routes, instead of by four routes as now.

For convenience, however, the four charts of existing routes will be found, together with the revised general Map of the Cave and a key to the same, in the introduction to this volume.

THE ROUTE OF PITS AND DOMES

THE visitor is at the foot of the rude stone stairway leading from the rim of the cavern's mouth. The patter of the waters falling from the little spring as it leaves the mid-arch forty feet above him, sounding again and again in mimic echoes from the walls and roof around, gives him the first inkling of underground symphony. Looking backward he catches the last glimpse of the blue sky, forming a transparent background for the tall forest trees which seem to nod him a farewell. A fleecy cloud or two floats lazily across the bright sky; the cheery chirp of a thrush is borne to him, wafted on the incoming breeze; the same air current shakes to and fro the graceful maiden-hair ferns which fringe the opening above and about, or makes tremble the green leaves of the trees, made greener still by contrast with the dull gray of the limestone wall. All these things the visitor will note if he be a lover of Nature, and then he turns to obey the summons of the guide and faces—darkness! The rill at which he for a moment had looked plunges into the bottom darkness, and so will he. It seems to him a fit emblem of his own life, from night to night, but a brief day.

Passing along on the right for a distance of fifty yards or more the Iron Gate, rendered necessary to prevent the work of vandal hands on the formations of the cave, looms dimly before us in the gathering gloom. A moment's delay suffices to enter, and we have the consciousness of being at last under the earth, shut in from the great, beautiful world of light. Occa-

sionally there are found timid ones who here turn back, who can not remain unmindful of the darkness and its thousand uncanny impressions, and so would find little real pleasure in the journey now well begun. But such persons are few; the majority of visitors appear to have little thought of surroundings other than a lively sense of something novel, and hasten eagerly forward to sound the mysteries which lie in the darkness beyond.

One's impression of Mammoth Cave, favored by the great arched entrance, may here receive violent amendment, for the walls are close on either hand and the roof is so low that one must stoop as he passes along. But dangers to head and feet are successfully avoided, and now we pass through Hutchins' Narrows. On either side the loose rocks have been piled in compact manner, leaving a narrow passage of but few feet in width. These piled rocks bear silent testimony to the toil of nearly a century ago, when the miners laid them as the visitor sees them, that they might easier carry their burdens to the upper world. Under your feet pass the pipes, bored with great toil from long stems of trees, through which was carried the water of the spring that we saw at the entrance, to be used in the leaching vats within, as well as to carry it back again when it had accomplished its work of solution and was ready for the clumsy chemistry of the day at the mouth of the cave. To the left, about half way down the Narrows, rest the bodies of two of the aboriginal owners of the land, found in the soil by the earliest miners and reburied at this place. Their tomb is the ancient soil, their monument the rude piles of rocks which the visitor passes, usually unconscious that here lie these primitive children of the New World.

As the visitor passes along the Narrows, suddenly the walls will begin to recede; his pathway lies down a small hill of some ten or twelve feet, and darkness, but slightly dispelled by the fitful glare of his lamp, alone confronts him. The guide announces that the Rotunda has been reached, and the fitness of the name is apparent. Above him sixty feet is the grand arch which forms the roof of this immense hall, broken into folds and frets of great beauty along the upper margin. The ceiling is one great expanse of whitish limestone, unsupported by pillar or column, and is formed by the junction of the two large avenues which at last take shape as one's eyes become accustomed to the gloom. That great avenue to the right is Audubon Avenue, and will take us to Olive's Bower, containing some of the most beautiful stalactites to be seen in the cave. To the left stretches away for miles the Main Cave, a wonderful avenue of great height and width, full of attractions for the intelligent observer.

The guides will tell you that the Rotunda is immediately under the hotel which the visitor left a few minutes before. There will be pointed out to you the first of the crude leaching vats in which the early miners obtained the lime nitrate for use in making saltpeter at the mouth of the cave, as has been already explained in the historical chapter. Then will come the brilliant illumination, and for the first time the grandeur of these underground halls is clearly made visible. As the Bengal lights burn brightly the great circle of the central roof comes into view, and, if in late fall or winter, thousands of bats, in the long sleep of winter, will be seen pendent from the angles and walls. The two great avenues leading from the Rotunda become

still more marked whenever the bright light of illumination only extends the boundary of their eternal night, drives it back but a little way farther and adds to our conception of its blackness.

We will now pass down the avenue to our right, named for the celebrated ornithologist of Kentucky, noting the vertical side walls, free from rock talus, as we go. To our left, well down in the middle third of the wall, about five hundred feet from the Rotunda, will be seen a low arch, forming the beginning of the first side avenue. This is the Little Bat Room, named for the myriads of bats which in winter may be found here. The avenue along which we are passing was originally called the Big Bat Room, but Kentucky's eccentric naturalist, Professor Rafinesque, named it for Audubon, his rival brother student of Nature.* Little Bat Avenue leads by a winding way, described in another part of this Manual, to Klett's Dome and to Crevice Pit.

Four hundred feet beyond the opening into this avenue the roof and walls make a sweeping turn to the right, and leave an apparently immense hall on the visitor's left. This hall extends only some three hundred and fifty feet, ending in a great hill of sandstone and limestone debris, sixty or more feet high, which completely occludes the avenue. To this room the name of Rafinesque Hall is given, while to the hill itself the fancy of the guides has affixed the name of Lookout Mountain. This is the underside of a "sink-hole," and from it the geologically instructed visitor may learn valuable lessons. From the irregular opening in the

*Now included in Route II.

roof of the farthest portion of the hall, water falls, keeping the rocks, everywhere cemented with lime carbonate, in perpetual dampness. One entomologically inclined may here find rare specimens of blind beetles and an occasional "cricket"; but life is not abundant.

Returning to the great avenue which we just left, we find the walls become more vertical still for some distance, while the arch overhead seems to widen as we advance. Soon, however, the roof approaches the floor, the visitor unconsciously traveling upgrade, and we are confronted by a wall of rock, around which we pass through a narrow defile. Then the mushroom beds, described elsewhere by Doctor Hovey,* appear, two or three stone walls filled with dirt in an unsuccessful attempt to force Nature to do something for which the natural conditions are unfitted. We look upon them as we pass by; perhaps we sigh at the cupidity of men who wish to improve upon Nature's laws; perhaps we laugh at the defalcation which left others with sad reflections on the honesty of their fellows.

Soon after leaving the Mushroom Beds the avenue again widens somewhat, though the ceiling is mainly low. But in the central portions the ancient waters had sculptured out an inverted kettle in the midst of a somewhat pronounced hall, and this is the rendezvous of myriads of bats. From the name of the genus which is so abundantly here represented we have given the locality the appellation of Vespertilio Hall. Thousands of bats, in the winter season, suspended in great clumps, may here be seen. A single catch one night

*A Mushroom Farm in Mammoth Cave. Scientific American, June 11, 1881.

gave Doctor Call six hundred and seventy individuals, most of which went to the United States National Museum.

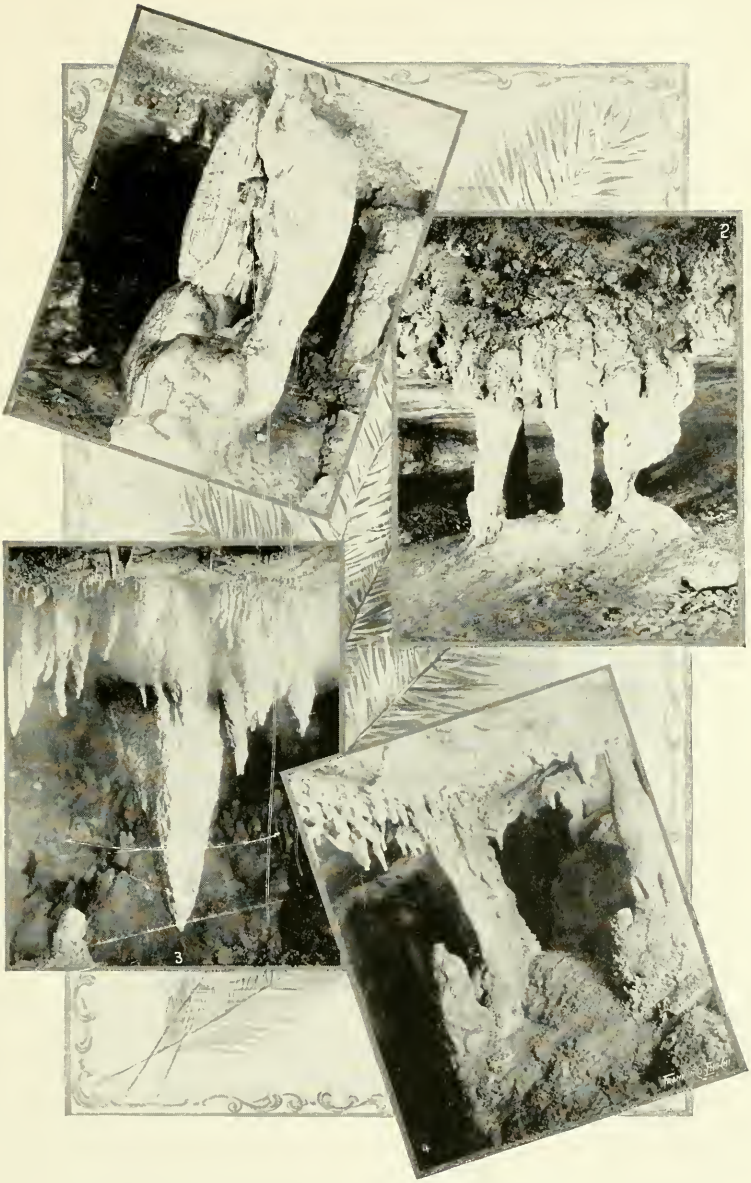
At this place and beyond, the great cavern along which we have been passing is practically below us, and we move along on a floor or filling accomplished by ancient streams many centuries ago. We here may note the character of the limestone roof which makes the top of every hall in all portions of the cave, for here we are nearest it. In some places we will find it smooth, in others thickly studded with small stalactitic concretions of various shapes, mimicking hundreds of familiar forms. Now we ascend a small hill, some twenty feet in height, and, passing between walls of flat rocks cemented with calcium carbonate, suddenly find ourselves confronted by the Sentinel, the lone stalactite which stands guard over the entrance to Olive's Bower.

This stalactite is one of the most beautiful in the cave. It has joined the stalagmitic mass beneath and seems, like another Atlas, to hold the world of rock above it in place. The waters which formed it spread out on the roof above, and now, surrounding its base, are numerous smaller ones, all hollow, from which minute drops of water slowly drip, like ornaments of brilliant hue, reflecting the rays from the dim oil lamps. They tip each tiny, slender tube with bright spots of white light, and sparkle like gems in their setting of dark gray stone. The stalactite itself is fluted and folded in a hundred fantastic ways, getting larger below and testifying silently to the long interval of time since first it began to form.

A step beyond and a deep pit arrests farther progress for the visitor. But springing from the middle of the

roof immediately in front of him is the most perfect cone-like stalactite in Mammoth Cave, yellowish white in color and flanked by many like it, but of less size. In the upper foreground are to be seen hundreds of smaller ones, all hollow, some uniting and making groups, while others preserve their integrity for a foot or more, as slender pipelets of lime carbonate through which ceaselessly trickle the tiny drops that take materials from the limestone above and add them slowly, particle by particle, to their lower extremity. On the floor below are building larger and flatter masses, very slowly, but which will, in centuries to come, gradually grow toward the descending ones above and finally meet them.

Cautiously approaching, for the locality is not without danger, the visitor may look over the rampart of stalagmite and see below him, fifteen or twenty feet, a pool of pure water, which reflects from its mirrored surface the light of his lamp. This pool never gets full; the drops which supply it never increase either in frequency or in size. Its jagged walls are fluted and folded in ways indescribable. Beyond are other stalactites, forming a gallery, and in the distance, among the innumerable crevices, are to be seen still others, but beyond examination, for the ceiling reaches quite to the floor and the avenue ends. It only remains to say that these formations are quite like those of White Cave, and are probably connected with it and with those of Mammoth Dome, but are inaccessible from this locality. Olive's Bower terminates the underground journey in this direction, and we return to the Rotunda, not failing to note new aspects to the walls



The Arm Chair.
In Olive's Bower.

The Bridal Altar.
The Gallery in Olive's Bower.

of Audubon Avenue as we pass them in the opposite direction.

We are again in the Main Cave, having reached the Rotunda and turned to our right. High overhead springs the wonderful arch which here reaches some eighty feet breadth, rounding off gradually into the almost vertical walls along which we are passing. At our left the guide soon calls our attention to the Exit of the Corkscrew, that wonderfully intricate passage-way which leads to the rivers by another route than that which we will take to reach them. Yet, it is often the case that parties go this way rather than by the Scotchman's Trap and Fat Man's Misery, or if going the one way usually return the other.

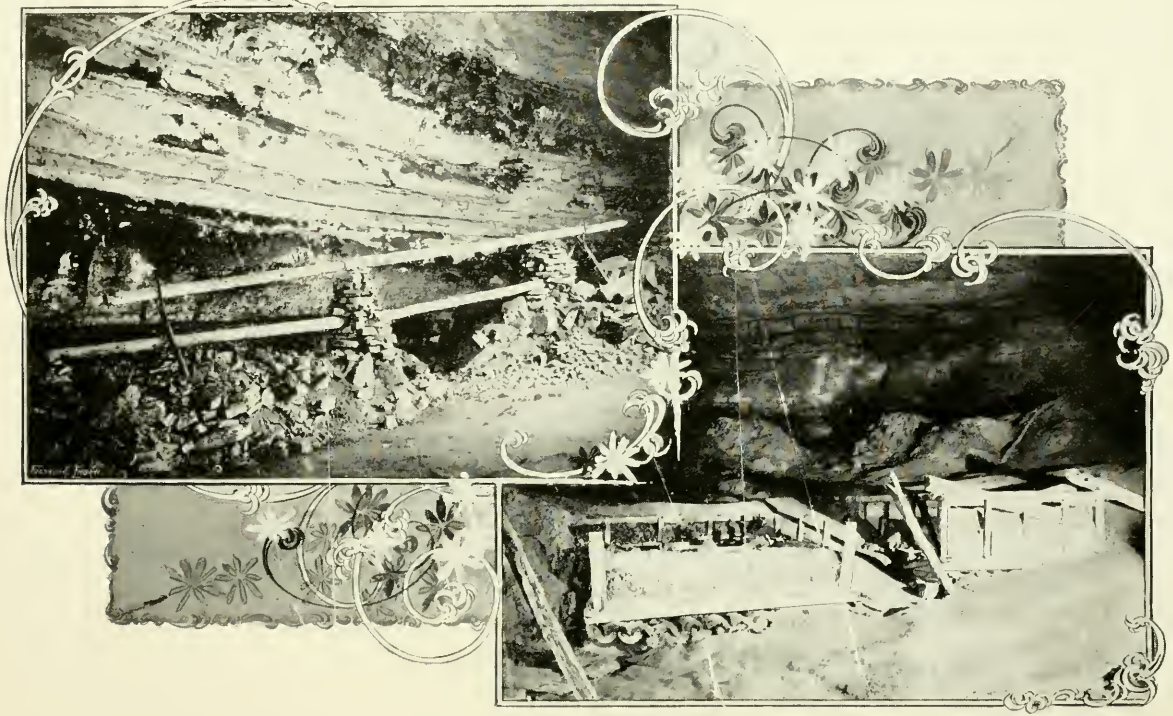
This passage is a most peculiar one, and is formed by a series of connected interstices between huge blocks of limestone that fill a pit of vast dimensions, the bottom of which, with its wealth of gigantic blocks tumbled in wonderful confusion, constitutes Bandit Hall, described elsewhere in this Manual. It is a brilliant picture that one may see if he happen near the Corkscrew when a large party returns from the river route after climbing this devious passage. The lights appearing one after the other and forming an irregular procession as the carriers wind along the precipitous face of the Kentucky Cliffs, in which the opening is, afford a weird and beautiful scene. In the angle of the cliff and crevice rests one of the old water-pipes used by the miners. The guide will inform the weary walker that he may descend into the Main Cave by its means should he prefer that method to the rude stone way. Overhead we note the grayish lime-

stone, mottled here and there with fantastic patches of oxide of manganese, to which the fancy of visitor and guides alike have given more or less appropriate names. If the visitor is not rather imaginative he will probably regard some of the names as less appropriate.

At a number of places in this part of the great cavern the abundant evidences of water action will arrest the visitor's attention. Close to the pathway will be seen the Pigeon Boxes, a name given to a number of small openings which are formed by the unequal solution of the ancient rocks.

A short distance beyond the Exit of the Corkscrew will be noted the flowing outlines of a great circuit of the cave, while to the right may be seen the water-pipes of the old miners of 1812, standing to-day as when left by those busy toilers. The lower pipe brought the water from the mouth of the cave; the upper one led it back, forced by primitive pumps, laden with lime nitrate in solution. It will be interesting for the visitor to note the perfect preservation of these old-time waterways, for though they have been in the cave for fourscore or more years undisturbed, they still show no sign of decay. Try and lift one of those that lie in the pathway and you will be astonished at its lightness. Perfect in all respects, they remain here faithful monitors of a patriotism now but a reminiscence.

Just beyond these pipes will be seen, well preserved in the lixiviated dirt, the tracks worn by creaking wagon with its load of "peter-dirt," or perchance the foot-marks of patient oxen, who here bore their share of the toil for the maintenance of our national integrity among the peoples of earth. At other places, on the sides, a



REMINDERS OF THE WAR OF 1812.

Old Saltpeter Pipes. The Leaching Vats.

little farther along, will be noted the grooves made by immense hubs as they were slowly pulled through the old-time mud. Then come the great heaps of lixiviated dirt, telling us we are near the second of the series of leaching vats. But just before this we will have passed the Church, the name given to the great hall formed by the union of the main cave and Archibald Avenue, a broad avenue on the left, occluded at a short distance by gigantic rocks and cubic yards of fine yellow sand. Tradition has it that originally the name was given because here were held religious services for the miners, in the olden time. However this may be, occasionally the over-Sabbath visitors number among them a clergyman, and these gentlemen sometimes hold services in this locality. The writer was present on one such occasion, when the senior author of this Manual conducted such an office. The sounds of sacred song, swelled to great volume by the ten thousand echoes and reverberations from the cliffs and grottoes surrounding, were indescribably sweet, and all tonic errors were corrected by the greater symphony of the large resonator hall.

And now we pass along the great piles of dirt, and when we remember that much of this material was brought to this locality in sacks, on the shoulders of slaves, from points often two or more miles away, obtained after great labor in removing tons of loose rocks and gathering the fine silt, a little here and a little yonder, we are impressed with the toil which was needed to procure materials for leaching. The hillocks of leached earth stand, many in number, on our right and on our left; we wind among them, we climb over

them; we think, perhaps, of their makers. But our mood must suddenly change, for our guides hurry us away to the vats themselves.

In the midst of these piles of dirt are the second series of vats, "hoppers" the older writers call them, which well deserve careful examination. They are from eight to ten feet in width, and perhaps four or five feet longer, and four or five feet in depth when empty. The rude bottoms are of particular interest, since they show the resourceful methods of the early miner. Logs, split into halves and from small trees, were used; these were afterward rudely grooved and placed in two layers, one resting on wooden supports with curved surface down, the second with convex surface uppermost and fitting into the grooves of those below. The waters after passing through the content of fine dirt were gathered by this primitive device and made to flow into small pits near the corners of the vats, whence they were conducted to a larger reservoir to be pumped to the entrance. The leaching accomplished, the exhausted dirt was thrown into the heaps you will see around you and another charge placed in the "hoppers."

At this point we leave the Main Cave for a short time and climb the broad flight of stairs, just beyond the vats, into Gothic Avenue.* At the topmost part of the cliff which we have scaled is Booth's Amphitheatre; here, once Edwin Booth, that celebrated actor, gave a rendition of one of the dramatic characters which have made his name famous, to test the acoustic properties of this hall. He stood on the large rocks

*Now included in Route II (from page 32 to page 39).

Booth's Amphitheater.

THE MUMMY.

The Mammoth Cave Mummy, or what was exhibited as such and described on page 33 of this Manual. This unique specimen of a naturally dessicated "mummy" reposes now in the United States National Museum at Washington, with a perfect history, and it was photographed by the late G. Browne Goode for the writer.

above us, on the right, facing in. From this circumstance the place gained its name.

The avenue into which we will now advance is not high, nor is it very broad, except in occasional places. The floor is somewhat irregular, while on every hand are to be seen the evidences of water acting as the agent of solution. The propensity of former tourists to make a record of their visitation may be seen in the names smoked on every wall, in some few cases scratched deeply into the hard limestone. The only thing that most of them ever did to hand their names down to other times consists in this single act of vandalism. Hundreds of such names will greet the visitor as he journeys through portions of this avenue. Frequently cards are left instead.

Among the numerous grottoes and alcoves worn out of the side walls by the ancient waters will be noted two or three of particular interest. One of these is the Mummy's Niche. This name has some historic significance. Away back in the earlier years of the cavern's history a mummy was found in Salts Cave, on the Mammoth Cave estate. This was made the subject of many interesting speculations, most of which have little value and less basis of fact, but came to assume literary importance. The mummy was brought to Mammoth Cave and placed on exhibition in this avenue, and in this spot kept for some months. Later it found its way to Cincinnati, by way of Lexington; thence it was taken to New York and exhibited, and finally removed to Worcester, Massachusetts, where for many years it remained. During the World's Fair it was on exhibition in the White City, and at its close became the property of the National Museum, and

may now be seen in Washington. The mummy never properly belonged to Mammoth Cave; the only human remains ever found within its limits were the woman and child who lie buried beneath the rocks in Hutchins' Narrows, near the entrance.

The chief objects of interest in Gothic Avenue are the numerous stalactites, which are found, however, near its far end. As we advance the character of the walls and the ceiling changes, the smooth, white areas give way to rougher ones, caused by the innumerable smaller stalactitic masses which hang from the roof. We will pass many State monuments, and to these we will add our quota, mindful only of the fair name of our State. What boots it if we take from that of a rival State and add to our own? Do we not know that this has been done by others, perhaps from our own? And so we take two, one to repair the damage done, the other to add our mite to the growing column! Kentucky's Monument is the largest of them all, reaching to the very roof; yet be it said, Kentucky's people know less of their great wonder than many from far beyond its limits. But now the monuments are all passed, and we reach the first stalactitic-stalagmite of the avenue. It is the Post Oak Pillar from some fancied resemblance to an old oak stump deprived of its bark. Springing from the roof about its base are hundreds of smaller forms, many imitating bunches of grapes, while it has grown downward and long ago joined the mass on the floor. Neither it nor many of its fellows are now growing; the avenue is one of the driest in the great cave, belongs to the upper levels, and the waters which form stalactites, except in a single instance, long

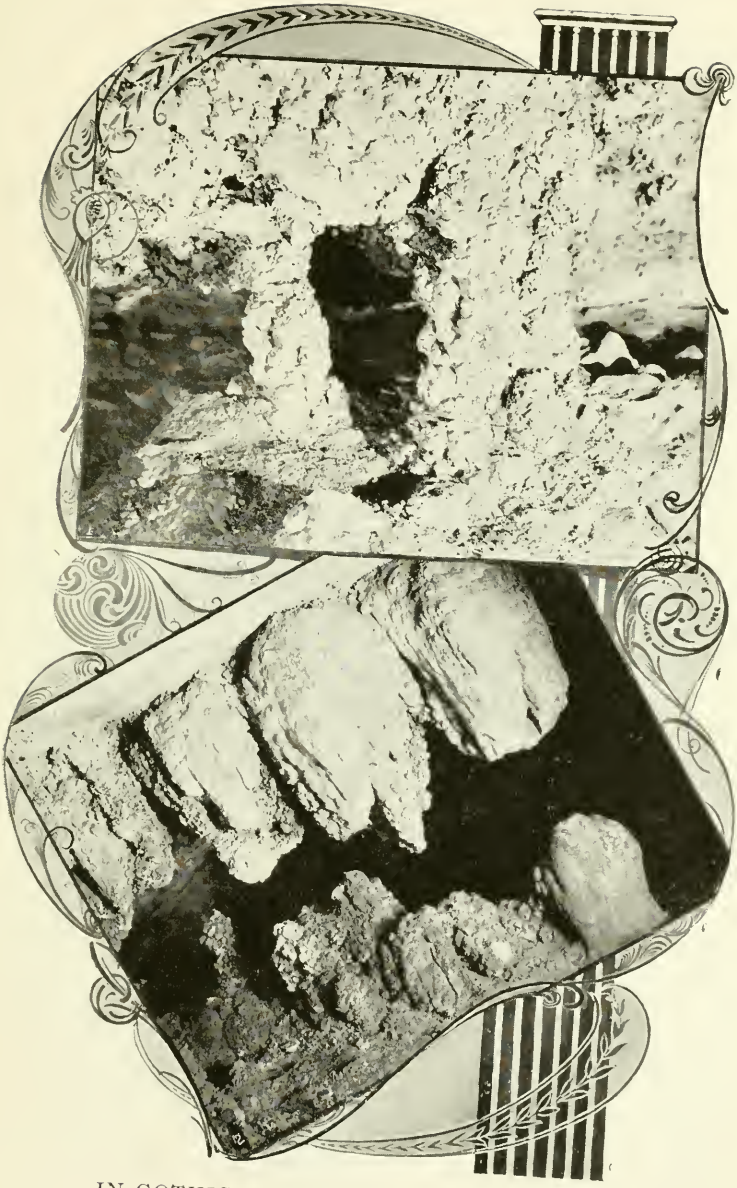
since left its locality. The Pillared Castle, the Gothic Chapel, the Pillar of Hercules, the largest group of stalactites in the cave, Pompey and Cæsar, the Wasps' Nests, the Elephants' Heads, Wilkin's Arm-Chair, all come in rapid succession, and are suggestive of caprice unrivaled in naming the several objects. Fancy, mythologic lore, caprice, sentiment, history, all have contributed to the nomenclature employed, and not always with best results. The eternal fitness of things has not always been kept steadily in view.

The Pillar of Hercules is a great matted series of stalactites which have grown entirely to the masses of stalagmite on the bottom, though the group is by no means solid. Aside from its size one could hardly imagine what suggested the name. Similar in its formation, but yet quite widely distinct in its integral members, appears next the Bridal Altar, in which thus far twelve weddings have occurred. The writer forbears to tell you the story which the guide will surely repeat at this place, for something must be left to the faithful pilot who has taken you thus far on your journey. Suffice it to say that the altar is made up of three separate stalactites, very large above and rather small below, which are so placed as to form a triangular chamber between them. One of these is the officiating clergyman, the others the chief actors in an important part of life's drama.

Having passed the Bridal Altar we come to the end of the usually traveled route and find ourselves on the brow of a steep hill, but looking out into the impenetrable darkness beyond. When we become accustomed to the gloom the faint illumination of our lamps discloses a deep pit before us, backed by a great hill of

sandstone to which the name of Limitation Hill is given. This name was suggested by the fact that the great avenue into which we have entered is occluded by the mass of sandstone debris which forms the hill, a fact to be seen at one or another place in every great avenue of the cave. Projecting over the edge of the cliff on which we are standing is a long and slender rock, the Lover's Leap, though the name is not suggested by the occasional use of the Bridal Altar, near at hand. From the point of this rock the illumination, by means of Bengal lights, shows a wild and tumultuously grouped mass of rocks, and down them leads a narrow pathway which parties sometimes take to other wonders below. This Hill of Difficulty leads to a narrow opening in the face of the cliff, fifty feet below us and on the left.

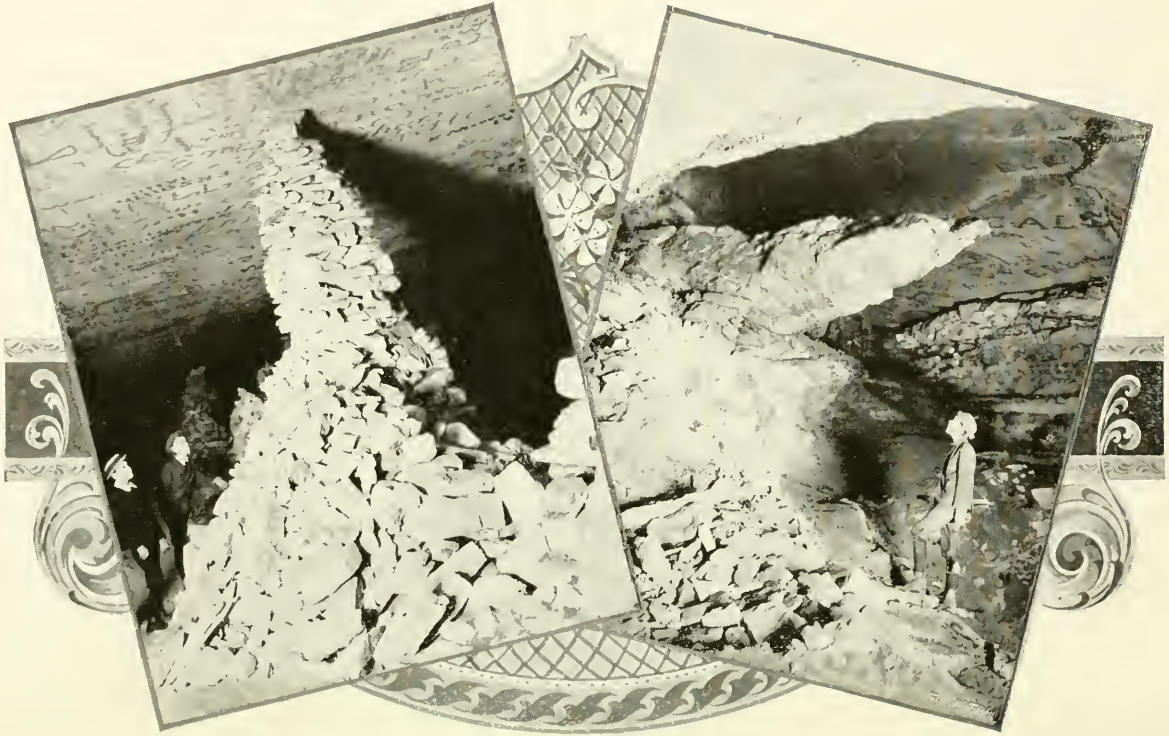
The opening, which can not be seen from the brow of the hill, is high but narrow, and suddenly appears before us in the face of the solid rock. This is Elbow Crevice, much like the Fat Man's Misery, but lofty and the walls wrinkled and folded in many fantastic ways by the waters which have long since ceased to fall here. The narrow pathway in the crevice skirts a shallow but ragged pit, the first we have seen upon this journey, called Joseph's Pit. Its ragged edge so hides the bottom that the passer-by fails to note the jagged sides of the pit unless he go close to the margin, which is, however, not without some danger. He then learns that he is passing over a thin slab of limestone which separates him from the space of the pit; but one is reassured when he discovers the bottom at some ten feet below. Taking for a short distance the low avenue on the right we come to a limpid pool, in the bottom of



IN GOTHIC AVENUE.

An Alcove.

The Elephants' Heads.



IN GOTHIC AVENUE.

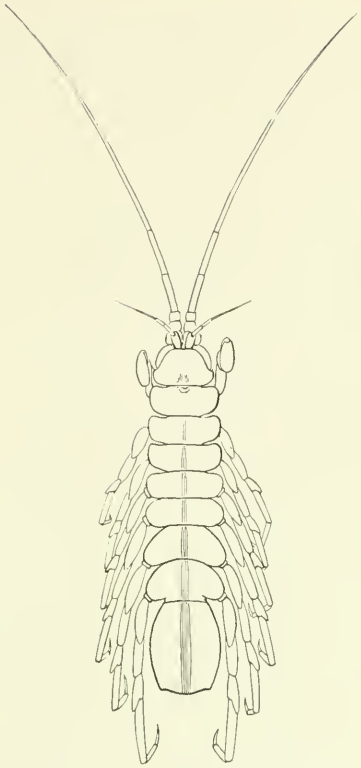
Kentucky Monument. Lovers' Leap.

a shallow basin, and this is the Cooling Tub. The yellow sands which make the floor here are suitable homes for the larval forms of the blind beetles which here abound, and which may be seen scurrying away, disturbed by the heat of our lamps. In the waters of the Cooling Tub careful search may reveal a few snow-white crustaceans crawling over the bottom, but without eyes. Back again into the end of the crevice we come to the beginning of a larger hall, three quarters of a mile in length, where is the first dome we have seen, Napoleon's Dome. The huge rock under it and around which we pass is Gatewood's Dining Table, and is a great block of limestone detached from the very middle of the apex above. We are here immediately under the Elephants' Heads of Gothic Avenue, and have passed under the Bridal Altar. The avenue along which we are to go is Gratz Avenue, entirely distinct as a geological feature from Gothic Avenue, of which it has usually been regarded a continuation. But it is at a much lower level and far later geologically than the one above us. A short distance beyond we come to Lake Purity, a small pool of water which has long been known to visitors to the cave by another inappropriate name bestowed by Doctor Ward, one of the first explorers of the cavern. So well deserved is the modern name that the visitor will certainly walk into it unless the guides check him. No breeze ever ruffles its mirrored surface, and no drop of water ever falls into it from above. It is supplied slowly by an almost imperceptible stream on one side, and this rarely ever raises its level. Twice has the writer walked into it, though perfectly familiar with its surroundings. Past the little lake is the Cinder Bed, well named indeed, and some-

times, like the Arm-Chair of the gallery above, connected with the name of his Satanic Majesty and then known as the Devil's Ash-Pile. It is a mass of small rough limestone concretions or stalagmitic masses, cemented together by carbonate of lime.

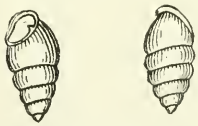
For a long distance the avenue winds now to the right, now to the left, keeping almost uniform height and width, with floor of rough rocks and broken stones, until the sound of falling waters reaches our ears. The visitor will pause to listen and to look. Whence they come he knows not, and this fact makes the sounds appear more uncanny still. But after he clambers down a small cliff he will wind suddenly to the right, and the low entrance to Annette's Dome is before him. Entering this dome he will have his first view of the work of falling waters. Merrily dashing from a hole in the face of the dome twenty or more feet above him and falling in a hundred sprays comes Shaler's Brook, running swiftly across the floor of the dome. Take up some of the pebbles in the bottom of this brook. Those soft and snow-white objects that yield to the slightest touch are the blind leeches which only have been found in this place and in Richardson's Spring. Perchance a half dozen larger and darker objects with legs will move hastily after the drop of water which circles the stone as you turn it. These are the same kind of crustaceans as you saw in the Cooling Tub.

But look up and around you. The walls are fluted and scored as by some gigantic graving tool. Here and there the harder layers of limestone jut out as sharp and serrated bosses partially obscuring the view toward the top. The dome will be seen to widen at the bottom and to shade off into a conical top, after



CÆCIDOTEA STYGIA (Packard).

From Annette's Dome. Found only on the under side of pebbles. A perfectly transparent crustacean, as white as snow.



BLIND MOLLUSK.

Related to the Melampus, a mollusk found in salt-water marshes. Found only in Mammoth Cave. Found and described by R. E. Call in 1893, and believed to be the only true cave mollusk known in America.

Annette Dome.

the manner of all others in Mammoth Cave. The incessant song of the little brook makes a music here which is to be heard nowhere else in the cavern. But what becomes of it? Wait a little.

As the visitor turns to go from this dome, at the left and low down near the floor, the side wall will be seen to have disappeared. On bended knee it is possible to pass into a smaller dome, adjoining Annette's, and then we hear the silvery splash of the waters in regions yet lower down. It is sad to think we can not follow the little brook and see more of the mysteries of this lower world. Out now we go, and as we are about to climb again the little cliff down which we descended we catch again the sound of falling waters, but this time with increased volume. Squeezing into a small opening under the little cliff on the right we may throw a light down a small crevice and find ourselves hanging on two thin sheets of limestone above a large dome, the bottom of which is filled with water and the sides of which are too remote to be seen. This is Lee's Cistern, and receives the waters of Shaler's Brook after a wild plunge of nearly seventy feet. The cistern is one of a large group of domes and pits whose more intimate acquaintance the visitor will make after a little, but at another place.

Leaving the dome and cistern behind us we retrace our steps to the Main Cave, by way of Gothic Avenue, but will first note the great hill of sandstone debris which occludes Gratz Avenue as we look on our right. Above it is a dome filled with huge blocks and sandstone debris; it is inaccessible. That hill is a famous place on which to collect "cave crickets," and an occasional specimen of blind myriapod may be taken.

We have now retraced our way, and are again in the Main Cave. As we pass along this portion of the great avenue we will note the lofty walls and the grotesque figures of animals which the deposits of manganese oxide on the walls and roof rudely simulate. Some of these are fairly imitative of the objects after which they are named; others require rather a vivid imagination to see the objects supposed to be indicated. From this point on to the place called Ultima Thule there is little variety in the walls that bound the avenue, but there is a constant succession of instructive localities and marvelous views which serve well as means of learning the real history of the cavern.

After walking a short distance beyond the entrance to the Gothic Avenue we come across the first large blocks of limestone which appear in the Main Cave. These are the Standing Rocks, so named from the fact that in falling they struck on their edge, and remain fixed in that position. The older name of the earliest explorers is suggestive of their aspect, for to them they appeared as a leg-of-mutton sail, and hence arose the original name of the Sail-Boat. Later guides and all recent visitors know them simply as Standing Rocks, and by that name must they now be called. That they were detached from the ceiling is certain, though they are vastly greater in size than most rocks which are found in the avenues and derived from the ceiling.

An accident discovered the remaining feature of interest before we reach the great sarcophagus-like rock which is near us on our right. This discovery came when two parties, one going out, the other entering the cavern, passed in this locality. An illumination was in progress near the Saltpeter Vats, when, looking

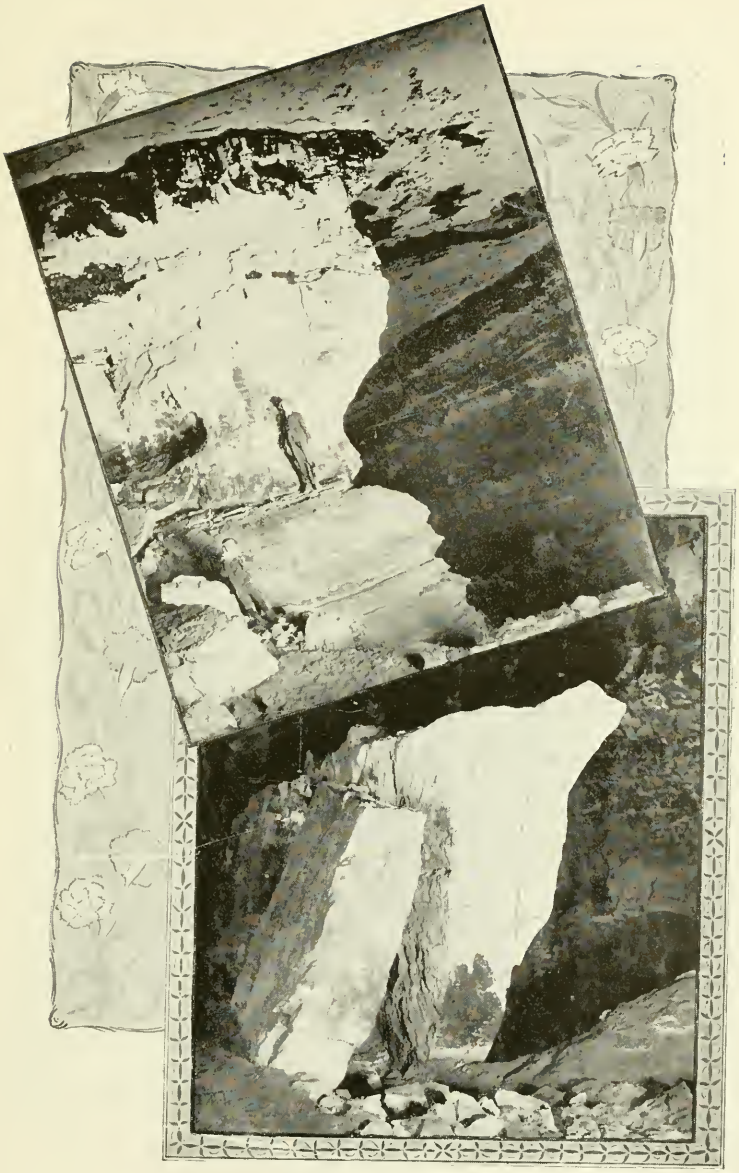
back, a statue was discovered as white and distinct as any Lot saw when his wife disobeyed the injunction and turned her gaze toward her old home. It is not salt which we notice but an illumined face of the cave cut off from full view by two interfering walls. The old-time style of the colonial dame appears before our very eyes, and "Martha Washington's Statue" commands our admiration from its exceeding fidelity to the profile of that distinguished "first lady of the land." While this object is but an illusion, it nevertheless interests us greatly and adds to our enjoyment from its very human aspect.

On the right hand, lying close to the right wall of the cave, the visitor will note an immense rock, one of the largest single rocks known in the cavern, to which the name of Steamboat was formerly given. But this old name did not long survive; it was hardly suggestive enough of the underground world to suit the fancy of the visitor, and then, too, its resemblance to a boat was little indeed. But it does closely imitate, on near view from the path, an immense sarcophagus, or rather perhaps we should say casket, for the burial of the dead. But did not the giants of old, that peopled our boy's world and all fairyland, dwell in the earth, and in caverns bristling with bones of victims and other suggestions of horrid underground feasts? What more natural than that here should be buried one at least of that ancient race of giants, and so tourists have ever since told us, and what all the world says is so must be so! We will accept the new name, manifestly so great an improvement on the older one, and the Giant's Coffin this rock shall forever be. But go up close to it and carefully note it. You will discover that it is an

immense block of limestone, torn from the adjacent wall, and falling but a short distance has become lodged in its present position. If you measure it a length of forty-five feet will result, its width will vary from twelve to fifteen, its height will be eighteen feet. Its weight is over two thousand tons. We will pass behind it later on, as we go to the pits and domes that are yet ahead of us, and be able to see this monster rock from three sides at least. Had it never fallen, the Way to the Pits and Domes would probably have remained unknown, but on breaking away from the wall it disclosed a low arch and narrow crevice through which the tourist winds into the devious Labyrinth. Over the coffin may be seen the emblem of the ant-eater, one of the most perfect of the color imitations in the cave.

Shortly after we pass the Giant's Coffin we find the great avenue along which we are journeying turn suddenly to the left at a place called the Acute Angle. Here one of the very remarkable things of the cave appears, and that is the sharp angle made by the underground waters in dissolving out this passage-way. The angle made is less than seventy degrees, about sixty we should judge, and does not often find an imitator even in surface streams. The immense hall, seen by illumination in both directions from this place, appears to fine advantage, and our impressions of the greatness of the cavern grow apace.

Beyond the angle a short distance there suddenly comes into view the first of the two stone cottages which were built here a half century or more ago. A number of poor souls, suffering under that dread malady, consumption, and under the advice of phy-



The Acute Angle.

The Standing Rocks.

The Statue.

sicians who appear to have had little knowledge of the real nature of tuberculosis, thought to find relief and possibly complete health in the cave. It was noticed that the water-pipes which the old miners had used and the timbers of their leaching vats were still in absolute preservation; it was reasoned from this circumstance, coupled with the fable that organic substances left in the cave do not decay, that the locality offered especially suitable homes for these people. So a number of them came, two dwelling in the rude stone houses which we see, the rest in tents located a little farther on toward the Star Chamber. What hopeful conversations these hard and cold stone walls may have listened to we may never know. But hope springs eternal in the human breast, and one doubts not that it found place here too. What with light work and much exercise, with song, conversation, hopeful questioning, and eager anticipation, the dark days, which knew no sunshine, wore slowly away. This dread disease, which may find momentary respite in sunshine and genial warmth, had fastened itself on these poor innocents, and they daily became weaker. For one the end soon came, but at the mouth of the cave, whither he had gone when he was certain that the end was near. A brief space of time, several weeks only intervening, and the last one was laid away in the final sleep. The curious visitor may learn who they were and when they died from the rude stone cairns which are in the old and abandoned grove back of the hotel garden. Their bones were removed in later years, but the memorial tablets are still there, gruesome reminders of the end of the brief life spent in the old cabins on which we are looking. Perhaps the

visitor sighs when he hears the sad story, perhaps he gives it no further thought. In what mood should we take it?

And now we come to the crowning glory of this route, one made famous by many writers both in prose and in song. As we wend our way along the smooth and well-traveled path we find ourselves at length at a small declivity, while on beyond stretches without end the great avenue, sweeping to the right and lost in one magnificent archway of absolute blackness. The roof, too, seems to have left us, and we gaze upward into unfathomed night. The guides announce the "Star Chamber," and proceed directly to make more real the illusion of the place. All our lamps are either removed or extinguished, and for the first time in our lives, mayhap, we may really know what blackness is. If the party will remain absolutely still, the darkness of the place will become oppressive. A little shrinking nearer the guide or a trusted friend when once we realize how dark the place and how helpless we are! But our guides told us to look up when they left us alone, and we look. Slowly, as we become accustomed to the place, the roof seems to lighten a little, stars come out one by one, twinkling merrily here and blinking at us in evident delight yonder, then a comet shoots across the mimic sky, and the glory of the milky way brings from our astonished lips expressions of surprise and pleasure. The illusion is perfect. The near ceiling, heavily coated with manganese dioxide, has been pierced here and there with fairy snow crystals of gypsum, and these have reflected the dim light of the lamps of the guides who left us to enter a small passage-way on our left. The snow-clouds were made

to appear, and night has come to us again. The spell is broken; we are, after all, in a world of illusions. But now the footfalls of the guides coming in the distance reach our ears, and, with some of them, a bucolic concert of familiar sounds, the blending of the barking of the house-dog, the crowing of the cock, a feline battle, the lowing of cattle, for a little time conspire to make us think we are still above ground. But now our ventriloquist guide has rejoined us, and we are told that the end of the route in this direction is reached.

We retrace our way to the Giant's Coffin with more than our usual thought, perhaps. We are prepared to understand Emerson's thoughtful essay on "Illusions," written after a personal visit to this cavern, of all the glories of which the Star Chamber seems to have impressed him the most deeply.

By rearrangement, the region from the Star Chamber to the Chief City and beyond it to the newly discovered Violet City is grouped as Route III, and contains many of the most interesting objects in the cavern. One in search of geological information relating to processes of cave-making will here find much to gratify and reward him which can not be seen elsewhere.

*The low arch behind the Giant's Coffin, to which we give the name of Dante's Gateway, is but slightly higher than the bottom of the sarcophagus itself, and the visitor will not fail to catch a view of the rear surface. From this he will learn the true thickness of the rock, which is eighteen feet. The passage-way between it and the wall from which it became detached is quite narrow; a series of rude steps lead us down and into a circular room, the bottom of which is cov-

*Now included in Route I (from page 45 to page 58).—H. C. H.

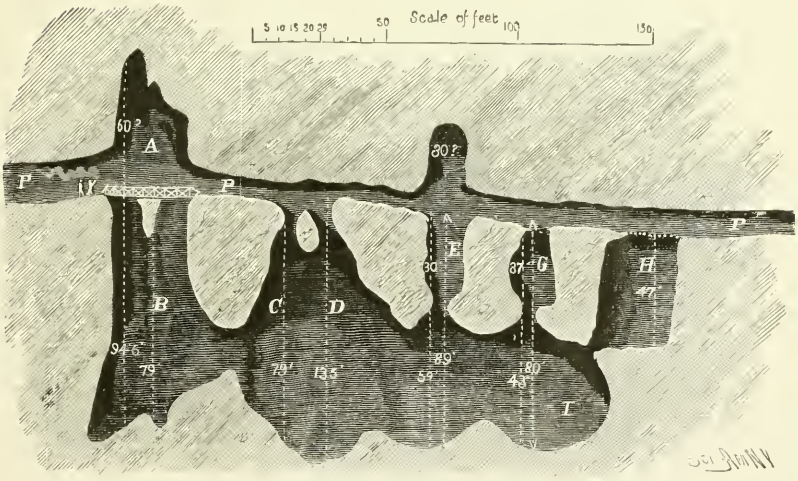
ered with fine yellow sand mixed at places with a quantity of small pebbles derived from a thin stratum of conglomerate which appears between the sandstone capping of the region and the Subcarboniferous limestone in which the cave is situated. This is the Wooden Bowl Room, resembling somewhat an inverted wooden bowl of old-time pattern. Tradition has it that a wooden aboriginal bowl was once found in this place, whence the origin of the name. The writer is, however, disposed not to accept this origin of the name but to suggest that it came from the resemblance referred to. Although this room is small it opens on great possibilities in several directions, and should be observed with the greatest care.

To the left you will note a low archway with well-trodden pathway; this is the beginning of Ganter Avenue, an account of which is given elsewhere in this Manual. To your right is a small opening, partially in the floor of the room and partially in the base wall. This is the old "Dog Hole," now called the Steeps of Time. Down this we will go with considerable care by a rude stone stairway, aiding our uncertain feet by a firm hand-grasp on the wooden railing placed on the right. At all seasons of the year the snow-white festoons of *Mucor,* a low order of fungus, hanging at times in shreds a foot or more in length, at others covering the railing and the rocks surrounding with dense white patches of cottony fibers, give to the place its appearance of age or antiquity. The steps are veritably hoary with years!

Safely down we are in the low and irregular Way to Pits and Domes. The entomologist of the party should

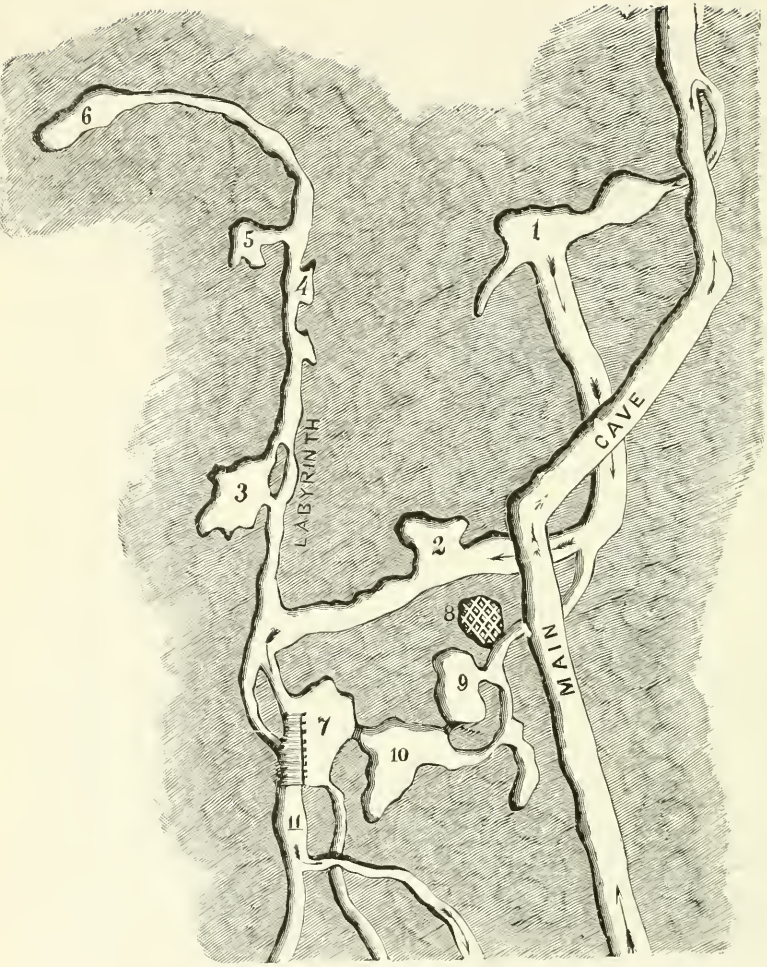
The Star Chamber.

Plan of Harrison Hall.



Section of Harrison Hall.

By H. C. Hovey.



Plan of the Labyrinth.

By H. C. Hovey.

here keep wide-open eyes, for this ground is famous for collecting. On the old timbers which he will find near the Way, under the damp, flat rocks, running along the white walls or leaping away from the warmth of his lamp will go innumerable crickets and white eyeless spiders and thousand-legged worms and brown blind beetles. Down a short hill the first water on the Route of Pits and Domes is seen in Richardson's Spring, a locality of the greatest interest. The work of running water will be noticed on every hand. The minute stream which slowly fills the little pool called a spring has quietly dug for itself a narrow channel, and illustrates the process which on gigantic scale has produced the cave itself. The spring contains many small crustaceans, and the flat rocks around shelter many interesting forms of blind insects. These will be more completely listed in another place in this Manual.

Soon after passing this spring, on the right, will be discovered Side-Saddle Pit, so named from its supposed resemblance to a saddle. Above it rises Minerva's Dome, while into it falls, drop by drop, the waters which are enlarging it and making it to rival its near-at-hand fellow. This is one of the smallest pits which the visitor will see on this route. But its walls should be closely examined, and he will discover how beautifully fluted and scored they are. At the bottom, fifty feet down, are masses of rocks detached from the overhanging dome, thirty-five feet above the observer. Just beyond the pit will be noticed a low avenue, Calypso's Avenue, which leads off to the left. This is never visited except by those who are veritable cave explorers, for it is dangerous in the extreme. The avenue leads to Covered Pit, a short distance away,

and beyond to Scylla and Charybdis, of which, however, more will be said in another place. At one locality, about five hundred feet within this avenue, the floor suddenly divides into two halves, and the visitor crawls along—the ceiling is so low he can not walk—with this narrow cleft slowly widening as he advances. Its edges get thinner; passing a lamp between the margins we find that we are above a great pit seventy-five feet deep, the boundary walls of which we can not see. We discover that our floor, the roof of the pit, is but a thin shell of limestone, and, impressed with the discovery, we hasten back. But still again the desire to know what is on the other side takes possession of us, and again we venture. This time slowly we move, certain of our way, and pass the Covered Pit to find ourselves gazing into blackness at the end of a beautifully arched avenue in which one may stand upright. We have reached the limit in this direction. The sounds of falling waters make music here, and we know that cave-making is in actual progress around, above, beneath us. By and by we shall reach the bottom of this locality, when its true meaning will be disclosed.

To the group of pits and domes which constitute this portion of the cavern the senior author gave, in 1889, the name of Harrison Hall, after the then President of the United States. The relations of these intimately connected domes may be gathered from the accompanying illustrations showing their ground plan and vertical section, correct in the main details. This portion of the cavern abounds in these great chambers, and, judging from the surface configuration over this section of the cave, many more similar domes are in juxtaposition and may be connected below. Since the

bottom of each is partially filled with debris from the walls and roof, it is impossible to make one's way from Harrison Hall into the chambers which are connected with it; but the waters, which sometimes gather in great volume in the bottom of Scylla and Charybdis, testify to intimate connection with the rivers and the lowest drainage levels of the cave.

It is but a short distance to the Bottomless Pit from the beginning of Calypso's Avenue. But before it is reached, the entrance to the Labyrinth, in the very floor of the way, will be discerned, and over it a broad and low archway, through the sands of which a road was cut in 1896. This is Darnall's Way, and leads directly to Gorin's Dome, from the end of which a most magnificent view may be had. When the writer re-discovered this passage-way, in 1895, it had remained unvisited for many years, and its existence had been forgotten by nearly all connected with the cavern. The sublime view from the edge of the mighty precipice, both to the right and left, should be seen by every visitor. Opposite the entrance at the dome end hangs an alabaster curtain in many sweeping folds, perpendicular to the very bottom, one hundred and nineteen feet below. Small streams of water are still engaged in cutting their way into the side walls, and the process of enlargement is slowly progressing. Since this dome-pit is typical of all in Mammoth Cave, and of dome structure in general in limestone caverns, it is worthy of more complete description. And this we now attempt.

The walls of this great pit change direction several times in their course of sixty feet, sweeping around into sigmoid curves in such manner that from no

accessible place can the whole be seen at once. The point of vantage is the bottom, reached from the farthest side of the pit by a dangerous and irregular well-like opening, with almost vertical walls, from which springs an occasional boss. Taking advantage of these the careful climber, by pressing knees and elbows against the sides, may descend a distance of some fifty-five feet and find himself on a mud-covered shelf, with greater danger still ahead. Carefully working one's way down this hill, which can not be seen from above, a bed of sand, when there is low water in the river which sweeps along its margain, is reached. On this was found an old boat, much decayed, indicating that this stream, which flows with a current of about four miles an hour by measurement with floating papers carefully timed, has some connection with the Echo River, or may be the real underground river of which the Echo is but a sluggishly flowing branch. At all events the bottom of Garvin's Pit, on the extreme left of the visitor, has a large underground river skirting its margins.* But the view upward from this point is grand indeed. Vertical walls rising one hundred and fifty-nine feet to the very top of the dome, with here and there bosses which on careful closer examination prove to be masses of coral, and these throw long shadows toward the top that move and wave in long black lines as the lamps flicker and swing; the drops of pure water, that like diamonds hang from the small pendent stalactites which in places cover the sides, the

*The earliest published account of this river was by Dr. Davidson, who describes it as "stretching away in midnight blackness a horrid pool of water." The boat mentioned above was built for Mr. F. J. Stevenson, of London, in 1863, and lowered through the window. On it he floated for seven hours, a perilous voyage never repeated.—H. C. H.

merry patter of several small cascades which come back to us from the river hall in a thousand small echoes, and the stillness otherwise, make the bottom of Gorin's Dome of real interest. Then, too, this is probably the only dome in the cave that reaches from the uppermost level to the level of the rivers. It is, therefore, the only place where the complete vertical range of the cave can be determined, an important factor in its careful study. The rock is here all oölite, and this seems to aid the waters in their work of solution. The dome is named from one of the original owners of the cave, Mr. Frank Gorin; the pit after William Garvin, the guide, who alone knew of the passage-way to the bottom, and who claimed to be its discoverer.

The width of this place varies from fourteen to twenty feet; its extreme length is about fifty-five feet; its outline irregularly dumb-bell shaped.* It broadens toward the bottom, after the manner of all the pits in the cave, and besides the mud and sand brought in at flood by the river, the bottom is composed of great limestone blocks. The bottom, or shelf part first reached, has a great quantity of old timbers, relics of former structures that were thrown in here to get rid of them. These constitute a famous place for blind beetles and myriapods, and we secured large numbers of them.

Returning to the Way of Pits and Domes, we pass along the margin of a narrow and deep crevasse worn into the solid rock and connecting, formerly, Gorin's Dome with the Bottomless Pit. We will visit this after our return from the regions beyond the pit, which is

*As measured by the aid of a cluster of small balloons, its height was found to be 160 feet.—H. C. H.

now at hand. A bridge, the Bridge of Sighs, enables the visitor to stand over the very middle of this abyss, from the bottom of which comes up to him the sound of falling water. At most seasons of the year the bottom of the pit contains only old bridge timbers and large masses of rock, with some very smooth banks of mud. At others, when the subterranean rivers are at flood, the left bottom portion is filled with water. This shows some connection with the Echo or other underground rivers, and also indicates that the commonly seen bottom of the pit is not as low down as Garvin's Pit. From the bottom of this pit, for notwithstanding its name it has one, the view is rivaled only by that of Gorin's Dome. Rising sheer above us to a height of one hundred and forty-five feet is Shelby's Dome, the top of the Bottomless Pit, named after the first Governor of Kentucky. The bridge overhead is garlanded and festooned with pendent masses of snow-white *Mucor,* while the light of the lamps we leave burning on the bridge show us the character of the fluted and folded walls, in most places absolutely vertical. We think of Stephen Bishop, the colored guide, who first crossed this place in 1840, his support being a slender cedar sapling, and we wonder not a little at his temerity. But that adventurous act not only made possible a visit to its bottom but was quickly followed by the discovery of the great River Hall, the Echo River, and all the other glories which have been so well described elsewhere by my fellow-worker. And not only this, but the exploitation of the two large pits which are connected with the Bottomless Pit, and which altogether constitute Harrison Hall, first described, and their relations made out by Doctor Hovey, and needing

The Bottomless Pit.

change in but few particulars from his original account. Do you ask how we reached the bottom? On your right hand, immediately after entering River Hall, you will note a small opening leading into an avenue which is nearly closed by a huge rock. Follow this a few hundred yards and you will find it branching. Do not take the right-hand branch, for that will lead you along a narrow avenue, here widening a little, and there with bottom close to top, and end at last in a small stream of flowing water that connects directly with the River Styx, and this bars further progress. Take the left-hand route, climb a low precipice, work your way carefully along, for it is somewhat unsafe, and you will enter the pit two thirds of the way down. The shelf on which you stand is narrow, muddy, and dangerous. To your right will be Charybdis, and beyond it the edge of Scylla appears in view. On the left is a difficult and muddy hill, down which it is possible to go with care, and you will eventually reach the bottom, if, like a fly, you can almost cling to the side. But the rough concretions will help, and the old timbers which are found here in numbers will assist. The bottom is reached at last, and the paradise of the insect hunter is attained. The lamps far above appear but as bright specks in the eternal gloom. Around you and about you are the evidences of fearful ruin, places whence the immense blocks of limestone on which you are now standing have been detached, while over your head, swinging from two small points on the surrounding walls of the pit, is an immense block which seems in momentary danger of falling and crushing you. It will fall some time, will continue its headlong flight toward the bottom, but it will only be after years of

patient solution yet, when the points will be dissolved away and the rock left free to fall.

After crossing the Bridge of Sighs the visitor will note an enlargement of the avenue and numerous large blocks of limestone. This is Reveller's Hall, suggestive of the dinner parties which were formerly held in this place. Since the River Route was discovered this hall has been abandoned for lunching purposes. To the left, just beyond, is a narrow passage-way leading into Fat Man's Misery and to River Hall, discovered by Bishop in 1840. But just before the narrow and devious Fat Man's Misery is reached, and before the Scotchman's Trap is passed, a narrow passage-way on the left will lead to the middle of the wall of the Bottomless Pit. From this point of view one may look down into the pit on the left, and into Charybdis on the right. In front, but twenty or more feet above him, is a well-rounded arch, which is the termination of Calypso's Avenue, along which we pass and over the Covered Pit to get our best view of Scylla.

There are two objects of interest beyond Reveller's Hall; these are all in the continuation of the avenue that now is called Pensico Avenue, along which we came to the pit. The first of these is Resonator Hall, where the avenue either crosses another avenue lower down or else passes above a dome in the strata below. Whatever the real explanation, the production of certain tones at this place comes back to us from below in volume increased a thousand fold, and rolls and reverberates along the secret galleries beneath. Then comes Wild Hall, where the large rocks are strewn about in abandoned profusion, and among

them we carefully wend our way. Next we come to the Grand Crossing, where once two great subterranean streams, at slightly different levels, flowed one above the other. They dissolved away the partition floor of the one which was the roof of the other, and now give us unique illustration of the ways underground waters will flow. At the end of this avenue is Angelica's Bower, and just before we reach it the large dry stalactite, the only large one on this route, fancifully known as the Pineapple Bush. From the walls and sides of the grotto hang numerous small stalactites, to which the name of Hanging Grove has been applied.

As we now return beyond the Bottomless Pit we note a narrow passage-way in the floor of the avenue and on our left. This leads down a steep hill of sand, obtained from the way over its top to Gorin's Dome. The walls are smooth in some places and furrowed and roughened in others. On them may be found, at all seasons of the year, innumerable crickets, and, farther along, an occasional myriapod. We are now in the Labyrinth. As we wind along, the wall on our left recedes, and crossing a rudely constructed bridge we stand under a small dome, above a pit now filled with fallen debris, but a few feet, five or six only, from the great Gorin's Dome. Up a short flight of stairs we proceed, down another on our right, turn to the left under the way we just came, and find ourselves at the Window. For many years this was the only way in which the tourist might see the great dome here disclosed to view, and the exhibition is wonderful indeed. Directly in front, hanging in fold after fold from the roof above as in tiers, is a great curtain of limestone

covered with incrustations of alabaster. It is limned against the intense blackness beyond, bending suddenly on our left and appearing to shade off into deepest gloom. The splash of falling waters alone comes to us from below, where is the swiftly but silently flowing river on whose bosom no man has yet sailed.* Its inky waters can not be seen from this place, but we know that it is there. From the farther side drops a little waterfall, and this splashes its way down the muddy hill at the bottom to join the river below it. The Dome appears from this point to be a large horse-shoe curve, but it is, in fact, sigmoid in outline and rudely dumb-bell shaped. The guides will illumine this view from another window still higher up, through which, if the visitor has a strong hand and nerve, and is a good climber, may be had a glorious view somewhat higher than any other the cave affords. But water everywhere drips in this dome and pit, and the attempt to make the climb is not without danger.

Returning to the narrow passage-way from which we diverge to go to the Window, we pass over a bridge across a rugged pit, descend a short hill, and wind along a devious and intricate series of channels which we will call from this on Hovey's Ramble. This name is bestowed in honor of the senior author of this Manual, whose work in American caverns is so well and so favorably known. It is a fitting tribute to his tireless interest in this great cavern and in testimony of the pioneer scientific work which he did that his name be affixed to these Dædalian passages. Several

*Except F. J. Stevenson, in 1863. The dams along Green River have caused the water to back up into these cave streams so as to make it impossible for any daring adventurer now to revisit "Stevenson's Lost River."—H. C. H.

localities interesting to the student of geology are here. They are instructive in the highest degree, and must be seen if the real work of cave-making is to be understood. To this point we have seen little of the actual work of water; only its results have been noted. Now we are to see it at work as a graving tool in one of the newest portions of the cave, newest in the geological sense. Down a rude stairway we pursue our way, up a cliff, alongside a deep pit, over several sinuous lower channels, hanging to the sides here and leaping from side to side yonder, over narrow chasms, until we hear the rush of falling waters and find our pathway occluded by a huge mass of stalagmite, while pendent from the ceiling are beautiful, sonorous stalactites of purest onyx. A narrow pass leads us around and behind this bower, and on our left stand revealed the rough and jagged walls of Putnam's Cabinet. Here in the pool of water, always full, we gather a pocketful of "cave pearls," gaze with interest at the waters falling from an opening in the roof, above us some thirty feet, and note that the dome is made up of a succession of layers of flat rocks which have differently resisted the action of the solvent waters. Every dome we have studied, if we could see its top, would present exactly this aspect, and from it we learn that solution alone has been the active agent that made the cavern. Several smaller domes at this locality present substantially the same appearance. They are connected by a series of small channels in which running waters may always be seen; from the roofs of some and openings in the sides of others small rills pour forth to add their mite, and might, to the work in hand.

Passing along the rough walk the cave here and

there broadens, then narrows, the roof rises away from the floor at times, while at others it approaches quite close to it. At every point the fitful light of the visitor's lamp brings into relief projections of infinite form and makes deeper the dark hollows between the rock bosses. The incessant play and change of light and shadow afford unwearied interest even where the walls, for some distance, otherwise offer little that is attractive. A half mile or less of this sort of thing and on our left, close up to the ceiling, in a widened area, we come to the end of the Ramble. This portion of the cave is continually wet, and the path sometimes lies through small pools. Last comes a great bed of yellow sand, in a large round chamber at the end. Did we say sand? Take up some of the minute grains in the hand and examine them carefully. They are round as shot, infinitely smaller, and uniform in size. Break off a fragment from that overhanging rock. Ah! We have it. This is not sand but oölite. The walls around us are oölitic limestone, and the solvent action of the waters has separated the tiny grains, and we thought them sand. But so thought others before us. The peculiar character of this limestone and the facility with which water dissolves its cementing material makes very treacherous this portion of the cavern. Do not trust the bosses on the walls for foot-rests; they are as likely to give way beneath your weight as to remain. Be attentive to your guide here and you will learn much of the processes now employed in making this portion of the cave. Here the route must, perforce, end, and from this point we retrace our steps to the Labyrinth, and through it, the guide, our Dædalus, takes us to safer grounds.

THE MAIN CAVE ROUTE

FROM STAR CHAMBER TO VIOLET CITY

THE term "Grand Gallery," or "Main Cave," was applied by early explorers to the gigantic Broadway of this subterranean metropolis, extending from the Rotunda to Ultima Thule. It is impossible to reach any avenue, dome, or chamber in the cavern without first traversing a portion of this central thoroughfare. The Main Cave, with its side-cuts, is three miles long, and is worthy of ranking as a route by itself. But it suits the convenience of the management to exhibit the first half of it in connection with the Pit and Dome Route; and accordingly that part of it is described by Doctor Call as far as the Star Chamber. What is now undertaken is to describe the remainder of the Main Cave, from the Star Chamber to the Chief City, and beyond it to the terminus, where the massive wall forbids further progress.*

After leaving the hall of constellations and marvelous transformation scenes, the gray cavern gallery makes a majestic sweep to the right. The black ceiling studded with stars changes to a mottled canopy, like a mackerel sky. Soon these clouds float away, and the remnants of black oxide of manganese coat only the fringes of the roof. The floor is encumbered with a myriad flat limestone slabs, every one of which tests one's equilibrium by tilting in a different direction, except where they have been adjusted so as to make a safe and conven-

*This is now made one of the four regular routes, and is known as Route III. It includes the new discovery, "Violet City" and its environs, described at the end of this chapter.

ient footpath. No stooping or crawling has to be done, and the main floor is everywhere absolutely dry. There is no danger, even of missing one's footing, unless one chooses to forsake the beaten way and ventures to see-saw over the rocking flakes that cover the floor in such endless confusion.

The guides point out many curious objects as we walk along. One of these is an enormous rock seventy feet long, formerly called the Keel Boat, but more recently christened the Whale. It is "very like a whale," and rivals in its dimensions the Giant's Coffin. A huge plate of standing limestone is labeled the Devil's Looking-glass. There are several "side-cuts," passages lower than the Main Cave, and that return into it after devious windings. These are never visited now, though they were ransacked by the miners for "peter-dirt."

Proctor's Arcade and Kinney's Arena are merely enlargements of the Main Cave, highly symmetrical arched passages, with lofty ceilings, and deserving the encomium that they make "the most magnificent natural tunnel in the world." The guides direct our attention to stout poles projecting from rifts in the roof, and we wonder how they ever got there. They also lift slabs along the margin of the cave and exhibit ancient fireplaces, with ashes and embers. These were described in Lee's "Notes of the Mammoth Cave," and also exhibited by old Matt to the writer in 1881. By whom were those fires kindled, and for what purpose?

This gallery used to be called the "Salts Room," or the "Snow Room," for the reason that the heated air from the lamps, or even a lusty shout from a guide,

brings about our heads a myriad floating, whirling, saline flakes, like a mimic snow-storm. On examination we find the seeming snow-flakes to be tiny crystals of sodium sulphate, detached from the ceiling by the agitation of the air. Even when all the cave is still and deserted they silently fall, pushed from the roof by the growth of new crystals, and whitening the rugged rocks by a perennial precipitation of saline snow. This is one of the most curious illusions of the cavern.

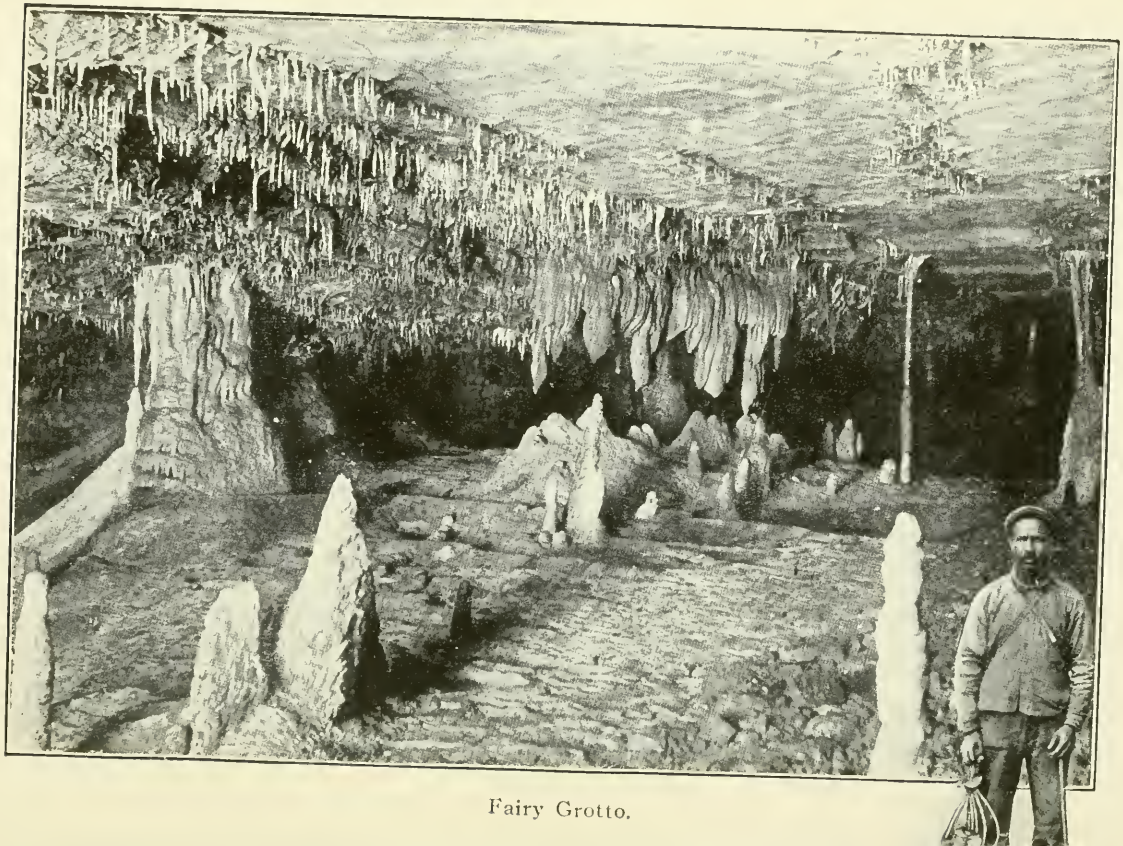
The resemblance of the Main Cave to a vast river bed, along whose channel, now so dry and dusty, once flowed a subterranean Nile, led the excited fancy of the early explorers to imagine the tremendous heaps of enormous rocks to be the ruins of demolished cities. Hence they named them "the First City," "the Second City," then came the Cataracts, and beyond them, as we shall presently discover, the "Chief City," and other cities, five in all. But we do well to observe the indications, in passing along, that this really was once a stream-swept channel. We find where the channel parted, was reunited, and then parted again, thus forming quasi islands that now remain as huge pillars from fifty to a hundred feet in diameter. The spaces between them are usually shallow, but when the arcade is illuminated the jutting bosses cast deep shadows, and the effect is as if we stood at the intersection of immense cross-caverns. The Sigma Bend winds along with serpentine course to the large Cross Rooms, where the narrow, tortuous bend suddenly expands to a width of one hundred and seventy-five feet, which it keeps for five hundred and fifty feet. Midway is a transept that expands the total width to three hundred and fifty feet.

(Lee's measurement, as quoted by Doctor Bird.) Thus the S-shaped bend opens into a T-shaped hall. Recent authorities call this magnificent room Wright's Rotunda, in honor of Doctor C. A. Wright, of Louisville.* Fox Avenue opens on the right and leads backward to a point where it re-enters the Sigma Bend, thus enclosing a large cave-island. On the left the transept branches around another island, and opens into what are termed the Chimneys, irregular crannies, through which one who is not averse to rugged climbing may reach the Black Chambers above. The black oxide of manganese, which we saw in the Star Chamber and Proctor's Arcade, instead of simulating the starry sky or the floating clouds, here swathes the walls and roof in absolute funereal black, while the enormous rocks tumbled about in the wildest disorder make a scene gloomy beyond description.

We now approach the Cataracts, and find ourselves on the brink of a steep hollow crossing the cave from right to left, partly filled with debris, but with sides rugged enough to make a descent into it dangerous. On the farther side of this pit stands a solid wall, while in the roof, on our right, are ugly holes from which streams perpetually fall into the chasm and vanish amid the rocks. There is quite a cascade, even in a dry season, and after a heavy rainfall the tumultuous torrent that descends amply justifies the term Cataract, and makes itself heard to a great distance.

By picking our way with care along a narrow path

*In Mellen's "Book of the United States" (1837), page 100, what is now known as Wright's Rotunda is called the Chief City, and the five great avenues leading out from it are minutely described, in the fifth of which was found the Fifth City, the same that was named the Temple by Lee, and to which Doctor Bird transferred the name of Chief City that it has had ever since.



Fairy Grotto.

on the left of the Cataract chasm, Doctor Call and myself reached what Doctor Bird regards as, properly speaking, the "termination of the Grand Gallery," that is to say, of the Main Cave; although the term continues to be popularly applied to a wide and lofty passage on another level, and of which more will be said presently. The spot we reached was very interesting for another reason, namely, because the immense weight of rocks and earth overhead had crushed the strata into a remarkable syncline exactly the reverse of the general arch of the cavern.

Returning to the Cataract, partly descending into the pit, and then climbing over a wall, we find a second avenue, near which is the way to the Solitary Chambers and the Fairy Grotto. The grotto was once one of the most beautiful places in the cave, with grotesque stalactites and other attractions that have since been marred by vandals. This fact and also the difficulty of access prevent this locality from now being usually exhibited to visitors.

Accordingly we will resume our journey by leaving Cataract Hall through an arch that admits us to a grand avenue commonly regarded as a continuation of the Main Cave, although really not identical with it. The path runs over limestone slabs that tilt and clatter under our feet, and between walls of monotonous gray, until, just as we begin to grow weary of the din and the sameness, the walls suddenly recede and we find ourselves at the portal of the largest subterranean temple in the world. This immense dome was called the Temple by Mr. Lee; but Doctor Bird first gave the name of the Chief City,

which had previously been given to what is now known as Wright's Rotunda.

The magnificence of the Chief City is not instantly appreciated, the first sensation being simply that of surprise at the recession of the walls and the boundless darkness before us. But when we climb the ruins of the mountain that rises from the floor, and the guide burns magnesium or red fire, we stand awe-stricken beneath the stupendous dome and vainly search with our eyes for the dim and distant boundaries of this majestic temple of silence and of night. The exact truth is here sufficiently impressive, and exaggeration seems an impertinence. The measurement made by the writer and Mr. Hains, in 1893, gave as the extreme length of the room four hundred and fifty feet, and as its average width one hundred and seventy-five feet. A simple arithmetical calculation will show the areal dimensions to be about one acre and three quarters. E. F. Lee, C. E., made it two acres. Doctor Call remeasured the room, in 1896, with a steel tape, exercising great care, and obtained the following results: Greatest length, five hundred and forty-one feet; maximum diameter, two hundred and eighty-seven feet; average diameter, one hundred and ninety feet. This would give the areal dimensions as about two and one-third acres. A good deal depends on where one begins to measure, for it is not quite certain where the spring of the arch actually arises. The line also has to be run over the irregular rocks, for which a varying allowance may be made. Estimates as to the height of the dome likewise vary from ninety to one hundred and twenty-five feet. But why concern ourselves with cold figures in a place that so fires the imagination? The reader

who has never been under this overshadowing canopy can not realize the vastness of that solid, seamless arch of limestone that has stood the wear and shock of thousands of years, and that may maintain its symmetrical span until the Day of Doom demolishes it, along with

> "The cloud-capped towers, the gorgeous palaces,
> The solemn temples, and the great globe itself."

The impressiveness of the Chief City is enhanced by utter solitude, as the writer can testify, having been, on a certain occasion, accidentally forsaken by comrades and guides, and left alone on the subterranean mountain at the solemn midnight hour. Sitting solitary, with no better light than that given by a single lamp, and even extinguishing that faint luminary in order to enjoy the luxury of absolute silence and Cimmerian darkness, it was strange what a rush of imaginary sounds filled the place, and how the fancy peopled the dome with uncouth and mysterious shapes. What a relief it was to break the spell by the simple method of striking a match, and what company was found in the cheerful flame of my freshly trimmed lamp! How welcome, at last, the approach of Doctor Call and his party!

The dust of untold ages lies on the huge rocks, amid which are found half-burnt bits of cane, which the guides assure us that the red men used to fill with bear's fat and burn in lieu of torches. Fragments of woven moccasins, and other remains, prove aboriginal visitation. Doctor Bird found these things, in 1837, filling the room "in astonishing, unaccountable quantities." The statement made by the early managers is that great bonfires of these combustibles were kindled to illuminate the mountain and the dome. But it is an

open question as to the motives that led the dusky aborigines to frequent this mysterious chamber. Did they here hold prehistoric councils? Did they find amid this rocky fortress a safe refuge from pursuing foes? Or were these earliest visitors, like the latest, led hither by simple curiosity? The first white explorers are said to have found aboriginal implements, pottery, blankets of woven bark, and other relics not unlike those found amid the cliff dwellings of Arizona. But who brought them to this subterranean hall, and whence came they, and when, and what was their fate, are problems for the archæologist. Pondering these mysteries we reluctantly leave the Chief City, with its assemblage of nooks and rocks, alcoves and monumental ruins, all aglow in the light of chemical fires, and overarched by that marvelous dome, which, as every observant visitor has remarked, seems to follow us in retiring, as the sky bends its canopy of blue over the moving traveler.

It is possibly a mile from the Chief City to the terminus of the cave in this direction. What meets the eye is a repetition of what we have already seen, only the rocks are if possible more teetering, and the task more wearisome of clambering over the piles of loose and irregular slabs of limestone. At intervals we are rewarded by spacious domes only less grand than that we have just been admiring. St. Catherine City is made by the intersection of two avenues. That on our right is the Symmes' Pit Branch, and ends in a funnel-shaped pit, called a "well," but dry now. The left-hand branch leads to the Blue Spring, and has a good path made by the removal of the rocky fragments. This painstaking work has been ascribed to the

Indians, but it was probably done by the old saltpeter miners in their search for "peter-dirt." Neither of these branches will repay the ordinary visitor for exploration.

Resuming our way from St. Catherine City, we presently come to two very beautiful domes, whose floors are covered with fine sand, and whose smooth walls arise symmetrically to an oval ceiling. As their former names were meaningless and inappropriate, we obtained permission to rename them. The first we christened Waldach's Dome, in honor of the late Charles Waldach, of Cincinnati, the pioneer in the work of subterranean photography, and who, as he told the writer, consumed five hundred dollars' worth of magnesium in taking some fifty views by the old-fashioned "wet process." The other dome we named Hains' Dome, in honor of our friend, Mr. Ben Hains, of New Albany, Indiana, who carried to perfection the task Mr. Waldach began under certain disadvantages, and whose explorations have also added materially to our knowledge of the mazes of Mammoth Cave.

Beyond these lovely domes we tread an ascending path over more tilting slabs, bending our heads low to avoid concussion against the roof. We are in the Garret, where salts abound like those we found in the Snow Room. Crystals hang from the roof and also spring from the earth in graceful forms. We pass a pile of sandstone rocks and approach a wall of dry, thin flakes of limestone from floor to ceiling. By an effort we thrust our way a few feet farther and touch what seemed to us a solid, impenetrable wall, beyond which no man could possibly go. After many futile efforts we gave up all hope of further progress, and named the

locality "Ultima Thule." But subsequent exploration has proved our name for it a misnomer.

A young German came from Berlin to America, in 1908, in order to learn our language and to acquaint himself with our country. His name was Max Kaemper. He visited Mammoth Cave, only intending to stay a few days; but prolonged his sojourn for eight months, during which period he made as complete an exploration of the cave as possible, with the expert assistance of Edward Bishop, as guide. Certain indications led them to suspect that a "tumble-down" in Sandstone Avenue might be identical with the pile of sandstone we had observed at Ultima Thule. Accordingly they attacked a limestone crawl-way near the latter and patiently removed the blocks of stone, not without some personal risk, till they had wormed their way through to an oval hall, one hundred and sixty feet long by one hundred and twenty feet wide and sixty feet in height. This place was afterward named, for its discoverer, Kaemper Hall.

They had been led onward by the music of an unseen waterfall, which was found to precipitate itself into what they named, for the guide, Bishop's Pit. They named another abyss for Mr. Norman A. Parrish, the Parrish Pit. There are in all eleven pits.

A short passage, fifty steps to the right, where is now fixed an iron gate, opens into Elizabeth's Dome, a symmetrical room seventy-five feet wide and as many high, ascending by vaulted arches to a circle at the apex, the name being given in honor of a sister of Mr. Kaemper. The Grand Portal leading out from it is an arch sixty feet wide and fifty feet high, commanding a general view of the wonderful region christened "Violet

The Marble Temple.

In Violet City.

City,'' in recognition of Mrs. Violet Blair Janin, the wife of Judge Albert Covington Janin, and one of the principal owners of the Mammoth Cave estate. Kaemper said the place reminded him of what the old German mythology called the ''Walhalla,'' the abode of the demigods.

Bengal lights were ignited here and there, and an automobile searchlight came to the aid of my smaller acetylene hand-lamp, thus well illuminating this wonderful region, which we found to be, by measurement, two hundred and fifty feet long by one hundred and twenty-five feet wide, a worthy rival of the Chief City and Wright's Rotunda as to size, while far excelling them in beauty. Following a rude pathway on our left we reached a sandstone tumble-down that gave color to the theory that some locality like ''Sandstone Avenue'' was near. A rich overflow of onyx binds the fallen blocks together.

By permission explosives were used at this point, until the indications made the manager feel that the process was quite as likely to burst to the surface as into Sandstone Avenue, and accordingly he called a halt. The result of continued effort would have been desirable in either event. In the one case an exit to the surface would have made it possible to return to the hotel by coach, and in the other a return by the Long Route would have been made practicable, without a wearisome tramp over paths already traversed.

Sound-tests by Kaemper and Bishop were agreed upon, to ascertain whether Violet City and Sandstone Avenue were neighbors. At a fixed moment, by the watch, revolvers were fired; but their reports were inaudible. Blows on the walls, however, were faintly

heard. Sound might travel far through crevices in the rocks; as was proved by the fact that, while in the Chief City, we heard plainly the steam cars of the Mammoth Cave Railway.

Violet City is rich in dripstone. Stalactites and stalagmites are seen by the thousand, and of every imaginable shape and color. The Chimes are stalactites that emit musical sounds, enabling one to play simple melodies by percussion. There are masses of fluted white onyx decked with brilliant crystals. Grotesque objects amuse us; for instance a bit of red onyx called the Ripe Tomato, and another formation named the Beer Mug because resembling a tankard of foaming ale. Thus far these, and other still more rare treasures, have been guarded from such vandal hands as have defaced or robbed too many curious and beautiful formations elsewhere.

This new discovery is a cause for congratulation. Hitherto Mammoth Cave has been noted for its paucity of stalactitic decoration; but the formations in Violet City are marvelous, and remind the visitor of the splendors of Luray and the Grottoes of Shendun. After surfeiting ourselves with this palace of beauty we have no short cut provided for us, but are obliged to go back as we came in, treading wearily the entire length of the Main Cave, yet richly rewarded by our recollections of the miracles in stone we have seen.

The Chimes.

THE RIVER ROUTE

TO THE MAELSTROM AND HOVEY'S CATHEDRAL

THE River Route has no equal of its kind in the known subterranean world. Its features are so unlike those of the Main Cave and the region of pits and domes as to make it seem an altogether different cavern—which indeed it really is. For the Mammoth Cave, instead of being one vast excavation, is a congeries of caverns, whose walls and floors were thinned by the action of water till they were broken through into one immense and intricate labyrinth.

Just as the visitor to Niagara wants to see the Canadian as well as the American Falls, to gaze on the impetuous rapids above as well as the tremendous whirlpool below the cataract, and to crown it all by a ride on the Maid of the Mist amid the seething caldron and sheets of spray, so the visitor to Niagara's rival, the wonderful Mammoth Cave, should take time to explore every route that is open for the public, and he will be amply repaid by an experience that will enrich a lifetime.

The River Route, now known as Route IV, often styled "the Long Route," extends to Hovey's Cathedral and the Maelstrom. It is certainly "long" as compared with the other routes; but no one in ordinary vigor should forego its remarkable scenes, utterly unlike anything found elsewhere. There are frequent stops at points of special interest, an ample recess for a mid-day lunch, and an interval of repose during the boat-ride on Echo River. Professor H. A. Newton, of Yale University, Doctor A. E. Foote, of Philadelphia, together with the senior author of this Manual, made an approximate measurement of the dis-

tance from the mouth of the cave to the end of the route at Croghan's Hall, and agreed in making it four miles and a half, not including the length of Echo River, which we had at the time no means of determining. In other words, the trip in and out would require about nine miles of walking, and the time usually allowed for it, including the boat-ride and the various stops, is eight or nine hours.* The fact should also be remembered that the spirits are sustained by the exhilarating cave atmosphere, which is as pure as can be found on any ordinary mountain top, as well as by the great variety and novelty of the perpetually changing subterranean scenery.

The River Route might be taken by itself apart from the other trips below ground; but it is more commonly reserved for the second day's excursion, and as a delightful sequel to the shorter routes that have already been described. We will imagine, therefore, that the visitor has explored the Main Cave and Gothic Avenue and the region of pits and domes, and has had a good night's rest at the hotel, before accompanying us on this new quest of adventure.

Down the valley again we go, led by the guides into the mouth of the cavern, under the thick horizontal plates of limestone, from whose green, mossy ledge the wild pattering rill falls forever with music on the rocks below. What becomes of it? No pool or stream is visible, but the cascade instantly disappears. An ice-house was formerly here, in the days of Doctor Croghan, and the excavation made for that purpose reveals the walls of a chasm that extends far below the accu-

*This does not include a visit to Hovey's Cathedral, for which a longer time must be allowed.

ON THE RIVER ROUTE

mulation of rocky fragments and indurated clay along which our pathway runs. We are really walking near the roof of a huge hall, like Dixon's Cave, but that is now filled by debris. The true cavern floor is hidden from sight by the broken rocks through whose confused spaces the cascade finds its mysterious way to the general drainage level and gathering-bed of subterranean waters, to which the deepest pits likewise cut their way, and which we are now about to approach by a more convenient route.

There are three ways of reaching the region of the lakes and rivers. Each has its advantages and its discomforts. Tourists who go in one way usually come out another, for the sake of variety. The first way, and the shortest, is through the opening known as the Corkscrew, near what are termed the Kentucky Cliffs, on our left and beyond the Rotunda. The other two ways are reached by going through Dante's Gateway, near the Giant's Coffin, and entering the Wooden Bowl Room. A passage to the left, from this room, is the beginning of Ganter Avenue, which leads beyond the rivers. By turning to the right, instead, and crossing the Bottomless Pit, we come to the Scotchman's Trap and the Fat Man's Misery, by going through which we enter River Hall. Each of these three ways will receive a more full description, in the order in which they have just been named: the Corkscrew, Ganter Avenue, and the Fat Man's Misery.

The Corkscrew is an intricate web of fissures, known as long ago as 1837, but not as a passage to River Hall, which had not yet been discovered. In one of the oldest published descriptions of the Mammoth Cave it is stated that "among the Kentucky Cliffs, just under

the ceiling, is a gap in the wall into which you can scramble and make your way down a chaotic gulf, creeping like a rat, under and among loose rocks, to the depth of eighty or ninety feet—provided you do not break your neck before you get half-way." That is a very graphic description of the Corkscrew as it is to-day, allowing for the improvements since made by removing obstructions and building stairways here and there, so that the passage is much more safe and practicable than formerly. William Garvin, the guide, was the first man to make his way completely through, in 1871, to Bandit's Hall, and thence to the River Hall. Those availing themselves of the Corkscrew have the satisfaction of reducing materially the length of the River Route, as compared with other approaches. It is in itself interesting, as already explained, as giving an example of an enormous pit that has somehow been filled up with gigantic blocks of limestone.

Ganter Avenue is the name now given to a combination of smaller avenues, effected by sixteen months of hard labor under the direction of Manager H. C. Ganter. It was platted in March, 1891, by H. C. Hovey and Ben Hains. Its total length, as measured by them, is eighty-five hundred feet from the Wooden Bowl Room to Serpent Hall; while the direct distance between those points is only about thirty-two hundred feet. Some of the guides first wormed their way through in September, 1879, and as they proved it to be possible for those caught beyond the rivers in a time of flood thus to escape to the surface, I named the new discovery "Welcome Avenue." But by authority of the owners I changed the name to its present form, in 1891, as a recognition of the tireless energy and skillful

engineering of Manager Ganter, who thus overcame obstacles that seemed almost insurmountable. The avenue as it now exists really cuts through three of the five tiers of Mammoth Cave. The passage, for a long distance, though forty feet high, was extremely crooked and also very narrow at the bottom. The latter difficulty was removed by laying a solid stone floor midway between the bottom and the top, thus making a wider path, though even now it is narrow enough to try one's patience. Many roughnesses were removed from the walls by judicious pounding and blasting; though enough knobs remain to serve as specimens of those that were formerly so numerous and exasperating. A remarkable stone stairway of one hundred steps, called "Rider Haggard's Flight," connects the three levels of the cavern, as mentioned above. There are branches leading from Ganter Avenue to various domes and pits and lovely crystal chambers, all inaccessible, however, to the general visitor. The main advantage of this avenue is that it enables the guides to take parties safely through to the end of the cave, at any time of the year, and regardless of the stage of water in the lakes and rivers. Otherwise we would hardly advise visitors to attempt this passage, unless they are resolute pedestrians and are willing to endure some degree of fatigue in search of adventure.

The third way of reaching River Hall, and the one usually followed either going in or coming out, is by crossing the Bottomless Pit and going through Fat Man's Misery. We leave behind us Pensico Avenue with its noble archways, Resonator Hall, and other attractions generally included in another route. We may, if we have time and inclination, turn aside for a

few steps and follow the narrow and winding passage to the left that leads back to a ledge near the middle of the Bottomless Pit, whence we also catch a glimpse of openings into Scylla and Charybdis. This is one of the most awe-inspiring spots in the entire cave.

But our direct path leads us through the tortuous channel to which the too appropriate cognomen of the Fat Man's Misery has long been given, in spite of every protest from those whose preference would be for some more poetical appellation. The walls of this serpentine channel are about eighteen inches apart, while the average space between the sandy floor and the stubborn rock overhead is only five feet. The channel changes its direction eight times in the two hundred and thirty-six feet of its length; and in the latter part of its course the floor comes up and the roof comes down to bother tall men as well as fat ones. Yet, after all, the difficulties of the passage are usually exaggerated, and it is doubtful if many visitors have ever proved too fat or too tall to get safely through by the kindly aid of the guides. Allowance must be made for the funny stories by which the trip is enlivened. Do not fail, amid your jokes and laughter, to notice how beautifully the rocky sides of the Fat Man's Misery are marked with waves and ripples, as if running water had suddenly been caught and petrified. At last we willingly emerge from the too close embrace of the rocky walls into a room fitly called "Great Relief," where we may straighten our spines and enjoy the luxury of a full breath.

Bacon Chamber, near by, offers a striking example of natural mimicry. Masses of limestone hang down like rows of hams and shoulders and sides of bacon in

ON THE RIVER ROUTE.

Fat Man's Misery. In Cleaveland's Cabinet.

ON THE RIVER ROUTE.

The Bacon Chamber.
End of River Route.
Victoria's Crown.
In White Cave.

a packing-house. The Odd Fellows' Links, the Atlantic Cable, and other concretions found along the crevices in the ceiling of the main avenue are all stalactitic. These grotesque shapes lead us to ask if the reader has ever noticed the true meaning of that word "grotesque," like what is found in grottoes; just as "picturesque" is like what we see in pictures.

We are now fairly within River Hall,* which really extends for miles, if understood to include all the ramifications of the passage-ways of the subterranean waters. Indeed, these come no one knows whence, flow no one knows whither, and emerge no one knows where. Conjectures have been made, some of them plausible, but positive knowledge of the mysterious subject is yet to be gained. It is known, in a general way, that these are the gathering-beds of thousands of sink-holes opening down from the surface; and that they come to the open air again in localities like the Upper and Lower Big Springs. But precisely what sink-holes and what springs are thus concerned, who really knows? The subterranean currents are capricious and contrary, now flowing one way and then another, obedient to local changes in hydrostatic level. No one who has ever seen them in their glory and their terrible flood-force can accept the theory that they find an adequate outlet in the springs just named. Those deep, bubbling pools, lying along the bank of Green River, under cliffs bristling with cedar and pine, are always submerged when that river is flooded. At such times, likewise, the cave rivers are flooded, forming a vast, continuous body fully two miles long, varying from

*River Hall is now exhibited on Route I, and passed over more rapidly in connection with Route IV.

thirty to sixty feet in depth, and sometimes even more than that. Torrents empty into them through the numberless sink-holes. Every cascade in the cavern adds its quota to the result. The flood may suddenly rise, but it more slowly retires, the subsidence of the waters being with a powerful suction causing eddies and whirlpools. There must be somewhere a suitable exit for this vast and tumultuous body of water. Such an outlet is visible five miles below Mammoth Cave, only it is on the wrong side of Green River, where a torrent bursts from the rocks with force enough to turn the wheels of a mill. The problem will probably be solved by a more careful exploration of the right side of Green River. We may say, in passing, that the theory held by Edmund F. Lee, C. E., that the accumulated waters of Mammoth Cave occupy a bed lower than Green River, and ultimately empty into the Ohio River, or even into the Atlantic Ocean, is proved to be entirely erroneous by means of barometric observations that have been made.

Our pathway skirts the edge of a cliff sixty feet high, under which reposes an isolated pool to whose sullen water the name of the Dead Sea is given. An iron railing guards the way for about a hundred feet, when we descend a flight of steps to a lower terrace. If we venture down to the margin and taste the water of the pool we shall find it sweet, instead of bitter like that of its Oriental namesake. Turning a few steps to the right we find a cascade which has been regarded as a reappearance of the waterfall at the mouth of the cave, although of this there is hardly sufficient proof. The cascade precipitates itself into a funnel-shaped hollow

of silt, and vanishes under a massive mud-covered limestone ledge.

In this vicinity the writer found, in 1881, a natural mushroom bed, that suggested the idea of a mushroom farm here, similar to those in France, whence thousands of bushels are annually marketed. My suggestion met with favor, and extensive beds were laid out in Audubon Avenue, on which many thousands of dollars were spent; but with meagre results for lack of suitable irrigation. There is no reason why the plan should not work well by proper methods.

The topic of eyeless fish and other aquatic inhabitants of the cave streams would naturally be treated here; but the reader is referred to the special chapters on cavern fauna for the desired information.

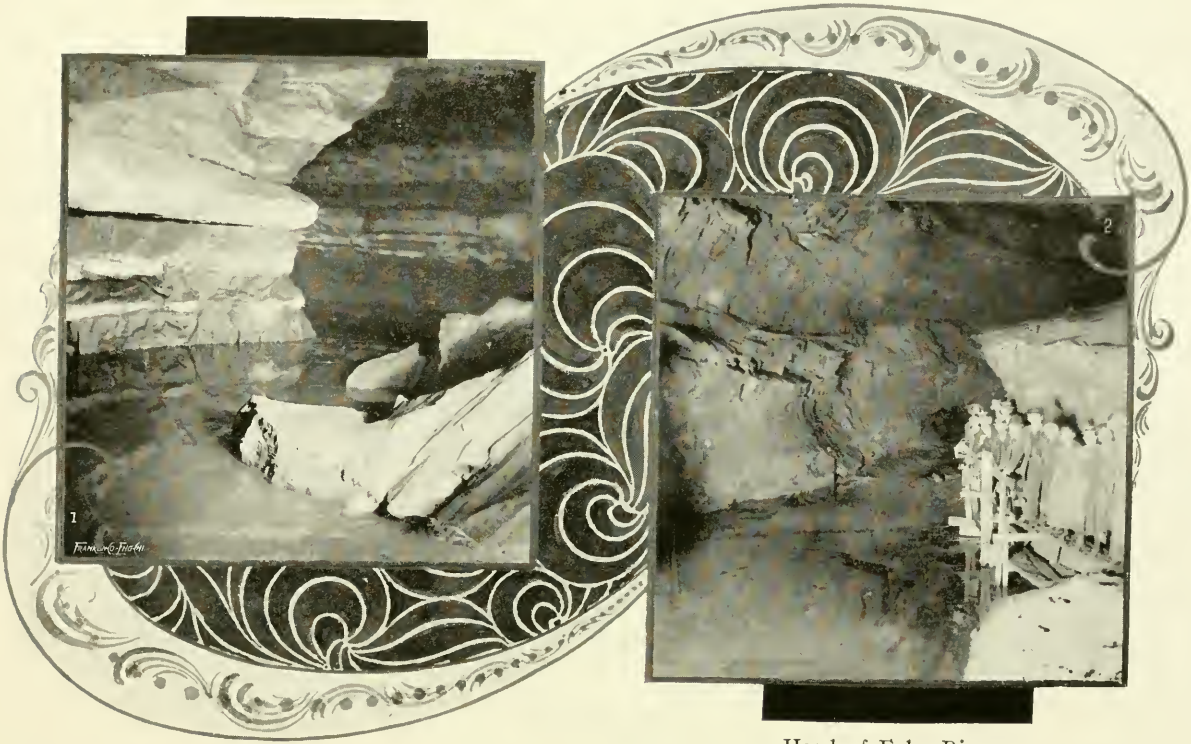
While speculating as to cascades, mushrooms, and blind fish we were startled on the occasion of our first visit by hilarious sounds that heralded the approach of another party. There never was a prettier sight than this merry company when they finally emerged from the darkness, sixty in all, with flashing lamps and spangled costumes. They wound past us along the sombre terrace, astonishing the gnomes by their jolly shouts and jovial songs. On they went, single file, behind a wall of stone, to come into view again on a natural bridge over the River Styx. The details of the wild scene were brought to light as they swung their lamps in order to catch sight of the mysterious banks on which we stood below them. The estimated length of the River Styx, whose black waters wind their way between the steep walls and underneath the bridge, is about four hundred feet, and its breadth is not far from forty feet. Formerly it had to be crossed by boats, but

now it is done by the natural bridge just mentioned. The spot was dangerous before a guard-rail was erected. Among the thrilling stories told of cave adventures is that told by William, the guide, of Professor Silliman's slipping from the bridge. The savant would have fallen into the Styx had not the brave guide sprung to the rescue.

On descending from the bridge we enter a lofty and spacious hall, where we find the placid waters of Lake Lethe, a body about as large as the Styx, and which was also formerly crossed by a boat. It is now partly filled with debris, allowing the construction of a narrow path along its margin to the pontoon that bridges its neck.

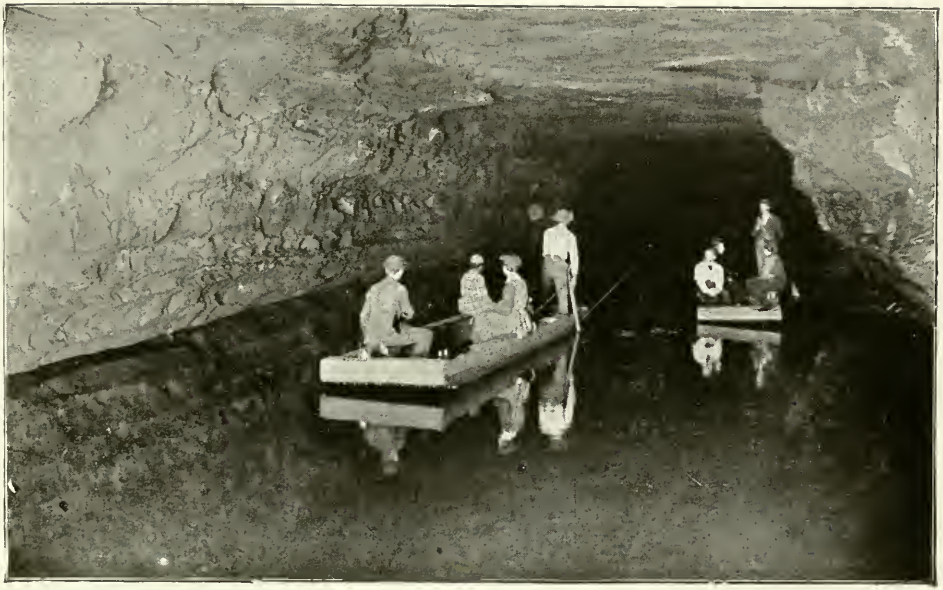
From this we step upon a beach of the finest yellow sand. This is the Great Walk to the Echo River, a distance of some four hundred yards. The ceiling here is not far from ninety feet high, and is most beautifully mottled with black and white limestones, like snow-clouds in a wintry sky. By igniting magnesium we get the wonderful effect in its splendor. Thus we also descry the marvelous masque of Shakespeare overhead. The actual likeness to the renowned Bard of Avon is striking. The Great Walk is only five feet above low water mark, and is submerged during the rainy season. Usually it is in good order during the months when tourists are most apt to visit the cave. As we walk along it let us keep a sharp watch for the *Cambarus pellucidus,* the blind and white crawfish for which the cave is noted. The earliest mention of it is the following:

"The river is a stream of water twenty feet wide and they say as many deep. It was discovered only



The Styx.

Head of Echo River.



On Famous Echo River.

about a year ago. Its current is very sluggish, as has been proved by launching a piece of wood bearing a lighted candle on its bosom. We were informed that a species of *white fish* were found here without eyes, and the keeper of the hotel assured us that he himself had seen them, but that their other senses were so acute the slightest touch of water overhead was sufficient to alarm them and make them dart off like lightning." Davidson describes the canoe in which visitors would row a short distance till stopped by a rocky barrier. Two of his acquaintances resolved to pass this barrier. "Accordingly, lifting the skiff over the rock, they launched it on the other side, and rowed, as they thought, for two miles. They beheld a great many new scenes and chambers never explored before. They also saw some of the white fish. As for us, on our visit, we were not favored with a sight of these natural curiosities." (Extract from a Report read before the Society of Adelphi of Transylvania University, January 16, 1840, by Reverend R. Davidson.) This was two years previous to Dekay's description, in 1842, and which is credited by Agassiz with being the first scientific mention of these interesting fish.

The first persons who ever crossed these waters were Stephen Bishop, the guide, accompanied by Professor Brice Patton, a teacher in the Louisville Asylum for the Blind, and Mr. John Craig, of Philadelphia. Those who now cross so gayly and with such manifest delight can hardly realize the degree of courage demanded for that first voyage of discovery across these subterranean waters. Mention of the Asylum for the Blind reminds us that at various times a number of blind people have visited Mammoth Cave.

Matt piloted a party of them through in 1880; and it was remarkable to hear them speak without any sense of incongruity of what they *had seen,* and about which they were as enthusiastic as any others.

A fleet of flat-boats awaits us on Echo River, or on Lake Lethe in case of high water backing in from Green River. These boats are built of planks and timbers brought in by way of the Crevice Pit and Mammoth Dome; though formerly every piece had to come in by the Fat Man's Misery. When not in use the fleet is moored by chains, though grapevines were used at the time of our first visit. Ropes are not strong enough to hold the boats in time of flood.

Each boat has seats on the gunwales for twenty passengers, who set their lamps down in a row in the middle of the craft. The guide stands in the bow and propels the boat by a long paddle, or by grasping rocks projecting from the ceiling. Usually but a slight current is to be noticed. Hence the singular inaccuracy of an imaginative picture by a French artist that has been extensively copied, representing the river as boisterous, and frantic oarsmen striving with might and main to keep the boat from shipwreck on the rocks. And as the only gale here is that which blows out from the mouth of the cave, there is equal absurdity in a striking picture that shows sail-boats on this calm and unruffled tide.

There are four arches, through either of which we may launch on Echo River. The first arch is only about three feet above low water, and if the river has risen a little, it is necessary to go on to the second, third, or fourth arch. In doing this we cross the Sandy Desert and flounder through a muddy place

named Purgatory. As has already been stated, there is a current of varying strength when the river rises above low water mark. The last time we were there the guide made no use of his paddle, relying on the current and his pointed staff to take us through. Once a party of journalists swamped their boat, but were rescued by the courage and presence of mind of both themselves and Nelson, their guide. Such mishaps are rare.

The voyage is usually replete with pleasure and with none but agreeable adventures. The archway overhead varies from five to thirty feet, while the plummet shows about an equal variation in the depth of the water over whose bosom we float. According to the barometer the surface is about twenty feet above the level of Green River, though observations differ, some making it more and others less than we have stated. The width of Echo River varies from twenty to two hundred feet, and its length is probably about half a mile. The stream can not properly be said to have any shore, as, except at the landing places, the rocks come abruptly down to the water. Along the margin are a myriad cavities, from a few inches to many feet in diameter, that have been washed out by the stream. These cavelets gave a wag who was in our party the first time we crossed the stream his coveted opportunity for a joke. "Oh, see these little bits of caves—three for five cents," were his silly words. The solemn echoes caught them up and bore them, as if in derision, hither and thither and far away, till he was ashamed of himself. When the peals of laughter that followed had also died away, a quiet lady in black velvet cave costume, with tiny sleigh-bells along the edge to

help people to find her in case she got lost, sang the "Sweet Bye and Bye," and the echoes were singularly sweet and pleasing. Then some one fired off a revolver, and the report rebounded tremendously from rock to rock. A native Kentuckian favored us with the famous "Rebel Yell," which was re-echoed as if a regiment was rallied from the recesses of the cavern. Flute music awoke delicious reverberations, and the cornet brought out corresponding effects. The tones of a full chord struck in quick succession brought back a sweeping *arpeggio*.

It should be explained that this symmetrical passage-way does not give back a distinct echo, as the term is commonly used; but gives a melodious prolongation of sound for from ten to thirty minutes after the original impulse. The tunnel has a certain key-note of its own, which, when firmly struck, excites harmonics with tones of incredible depth and sweetness, the lowest of them reminding one of the profound undertone heard in the tremendous music of Niagara.

The most extraordinary effects are produced when Echo River is allowed to speak for itself, and can only be had when the party is willing to maintain utter silence. The method is simply by the guide's agitating the water by rocking the boat and striking the water vigorously with his paddle. The first sound to break the intense stillness is like the tinkling of myriads of tiny silver bells. Then larger and heavier bells take up the harmony as the waves seek out the cavities in the rocky wall. Then it is as if all chimes of all cathedrals had conspired to raise a tempest of sweet sounds. These die away to a whisper, followed by mutterings and a noise as if of an angry multitude,

mingled with unearthly shrieks. Alarmed, we are ready to go to the rescue; but the guide motions to us to keep quiet and await what is to follow. We sit in expectation. Lo, as if from some deep recess that had hitherto been forgotten, comes a tone tender and profound; after which, like gentle memories, are reawakened all the mellow sounds, the silver bells, the alarm bells, the chiming cathedral bells, till River Hall rings again with the wondrous, matchless harmony.

As we land at Rocky Inlet the melody of a cascade greets us, whose falling water breaks into liquid pearls on the ledges. This is Cascade Hall. An opening on our right leads to Roaring River, a succession of shallow ripples and deep basins, navigable only by a canoe that can be carried over the portages. It has a remarkable echo, and offers points of interest to the scientist, but is never visited by ordinary tourists.*

Silliman's Avenue contains numerous places worthy of note. We first come to singular shelf-like projections called Wellington's Galleries. Then, at the Dripping Spring, we find the only stalactites seen since entering River Hall. The paucity of these natural ornamentations is explained elsewhere in this Manual. The guides, with slight regard for reverence, have named the next localities, in succession, the Infernal Regions, Pluto's Dome, and Old Scratch Hall. We leave them to justify their choice of names as best they may, and the tourist who disputes them will find that they are equal to the occasion. For instance, the ceiling in Old Scratch Hall is marked all over in a most extraordinary manner, which the guides assure us was done as a deed of darkness by the Evil One, although it

*Here now ends Route I, the rest of this chapter belonging to Route IV.

looks very much as if they had done it themselves with the tips of their spiked staffs. But the trails of the serpents in Serpent Hall are plainly freaks of nature, and are very singular. There are many of these winding grooves in the ceiling.

Here is the high water mark of Echo River in time of flood. And here, also, is the inner termination of Ganter Avenue, which runs from this place to the Wooden Bowl Room, near the Giant's Coffin, and affords an exit for any unlucky tourist who may be caught beyond the rivers during a sudden rise of their waters—a thing, by the way, that seldom happens. The Valley Way Side-cut is mainly interesting for its profusion of gypsum crystals that grow in the niches along the walls, and are dug from the ground like potatoes.

After descending the Hill of Fatigue we come to the facsimile of an enormous ocean steamer with her rudder hard aport; and as the unique resemblance was first noticed at the time of the launching of the ponderous Great Eastern, this was fitly christened the Great Western. Beyond it is the Valley of Flowers; and then Silliman's Avenue, which we have been traversing, ends in Ole Bull's Concert Hall, where the renowned Norwegian violinist once gave a musical entertainment. Just before reaching this hall, however, we notice on our left the entrance to Rhoda's Arcade, not included in the regular route. It leads by a winding and picturesque path, about five hundred yards in length, easily followed, to one of the most symmetrical domes in Mammoth Cave. The arcade is about ten feet high, and in many places the walls are incrusted with fine crystals of gypsum. Lucy's Dome,

thus reached, is about sixty feet in diameter and perhaps a hundred feet high, although enthusiastic admirers have credited it with thrice that altitude. The sides are composed of immense curtains reaching from the floor to the dim vault above. A twin-dome near by is connected with it by a tall archway. During our visit in 1896 we had the guides burn red fire in this window, thus illuminating both domes. The entire group is known as the Jessup Domes.

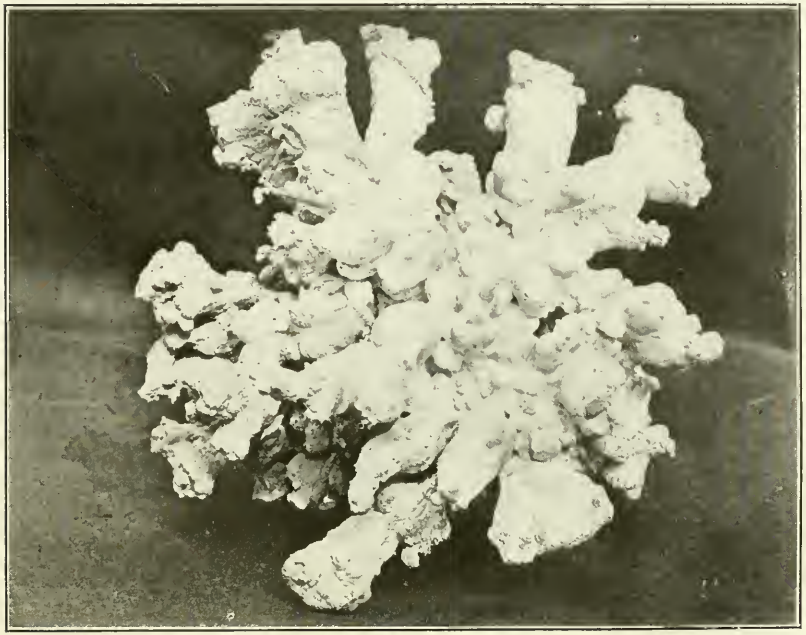
El Ghor is a wild, rugged pass, on a lower level than Silliman's Avenue. It meanders through the limestone like the dry bed of an ancient river. Overhead are the Hanging Rocks that never fall, though forever threatening to do so. In Fly Chamber, on the walls and rocks, are myriads of tiny crystals of black gypsum, each about the size of a house-fly. The Sheep-shelter is a rock jutting from the left wall for ten feet, and expanding for twenty feet in length. Victoria's Crown, sixteen feet in diameter, is on our right. Boone Avenue leads off to the left. Corinna's Dome is directly over El Ghor. The Black Hole of Calcutta is an ugly pit twenty feet deep. Stella's Dome, which resembles Luey's Dome, is reached by an avenue to the left. The guides also point out the Mule-stall, the Anvil, the Chimes, and other grotesque objects. Hebe's Spring, four feet wide and a foot or more deep, is *said* to be supplied with pure water at the top and sulphur water below. Boone Avenue, on our left, was for years blocked by a stone stairway now removed. We shall presently describe discoveries made in 1907 in this direction. But now, through an uninviting hole, we climb to Mary's Vineyard. A stalactite winds from ceiling to floor, and is called the Grapevine. Around it are countless nodules

of calcium carbonate coated with black oxide of iron, which simulate clusters on clusters of luscious grapes, gleaming with varied tints through the dripping dew. No covetous hand is permitted to pluck this subterranean vintage. By a detour through Elindo Avenue one may reach a natural chapel named by a priest the Holy Sepulchre. The walls are dark and bare, but in the vicinity are some fine stalactites. We are in an upper tier of caverns.

Washington Hall is a locality toward which we have for some time cast our longing eyes, not on account of its beauty, but because it is the usual dining-place for parties taking the Long Route. It is somewhat circular in shape and one hundred feet in longest diameter. Its walls are smoke-stained, and the floor is strewn with the relics of hundreds of dining-parties, while along its margin is a rampart of broken bottles left there by prohibitionists and others, once filled with milk, cold coffee, or other beverages.

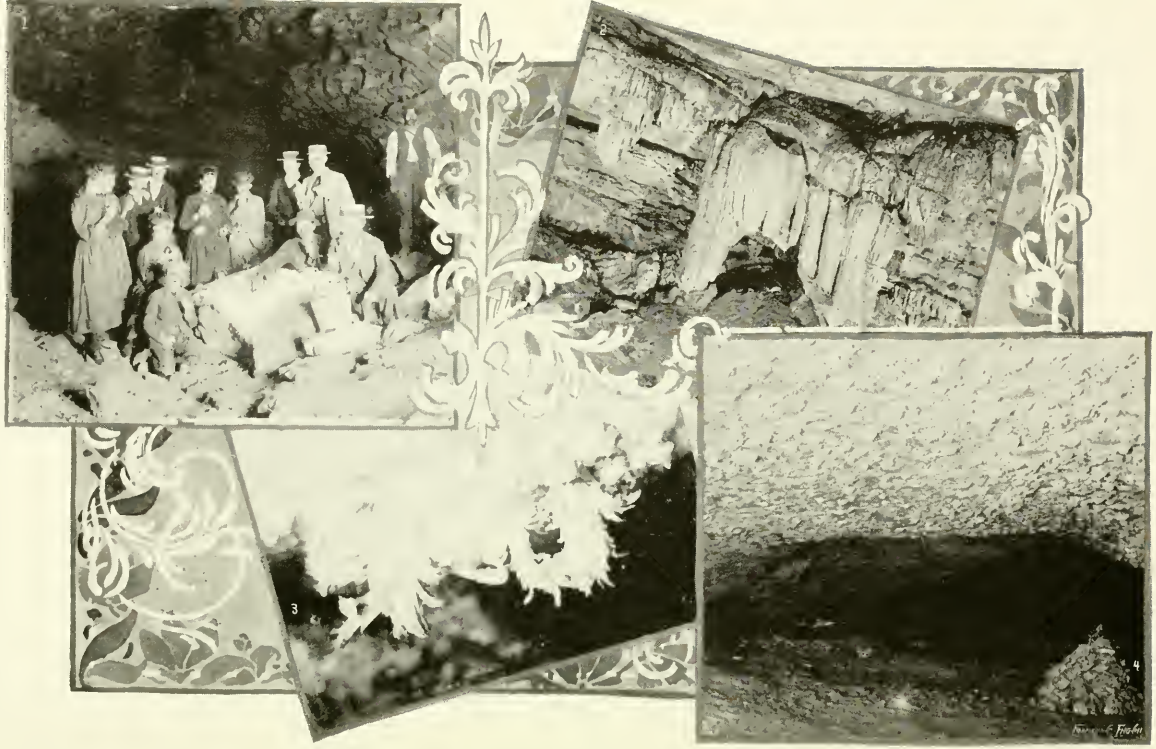
With appetites whetted by vigorous exercise and the bracing cave-air we fall to in primitive style and partake of the repast provided for us, forgetful of the fact that we are far below the brave sunshine and the verdant forests, and only mindful that we are hungry mortals. While we dine the guides trim our lamps and replenish them from cans of oil that are kept near by for the purpose.

Snowball Room comes next beyond Washington Hall. Its ceiling is thickly dotted with hemispherical masses of snowy gypsum, each being from two to ten inches in diameter. The effect is as if a crowd of merry school-boys had flung a thousand snowballs against the wall, which stuck there as mementos of their sport.



Collected and photographed by R E. Call. 1894.

BOTRYOIDAL FORMATION FROM MARY'S VINEYARD.



ON THE RIVER ROUTE.

Dinner Underground.
A Gypsum Flower.
End of Croghan's Hall.
The Snowball Room.

A charming side-trip occasionally taken is down Marion Avenue for a mile or more, over a clean, sandy floor, and under a cloudy ceiling. It has two branches: one to the left, leading to Zoe's Grotto, and the other to the right, through Paradise, with its fair and crystalline flowers, to Portia's Parterre. Digby's Dome has no special attractions, but is geologically interesting because it cuts through to the upper sandstone.

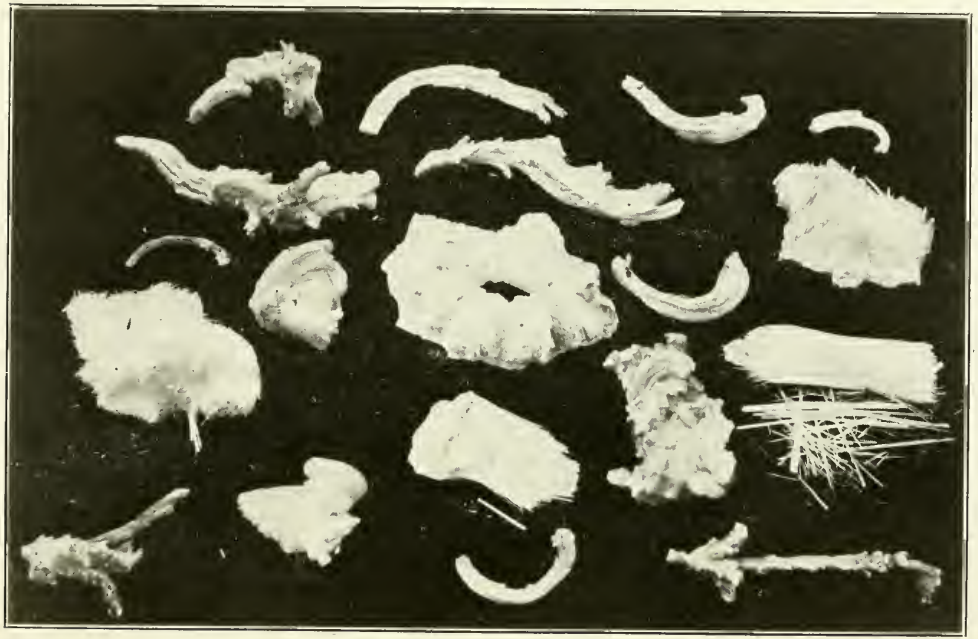
Cleaveland's Cabinet, which we next enter, is a long and singularly magnificent avenue, named for the late Professor Cleaveland, of Bowdoin College, the famous mineralogist. This treasure-house of alabaster brilliants was discovered by Stephen Bishop, accompanied by Messrs. Patten and Craig. It was first described by Professor John Locke, M. D., of Cincinnati, in a communication to the American Journal of Science and Art, in 1841, from data furnished him by Mrs. Anderson, a daughter of Mr. Nicholas Longworth. Doctor Locke was delighted with the gypsum rosettes exhibited for his inspection, some of which, he says, were a foot in diameter, whose acanthus-like leaves roll elegantly outward from a central disk; and he gave them the name of "oulopholites," or curled-leaf-stones.

We wander bewildered under symmetrical arches of fifty feet span, where the fancy is charmed by the natural mimicry of every flower that grows in garden, forest, or prairie, from the nodding pansy to the flaunting helianthus. Various names are given to the different portions of the general avenue, such as Flora's Garden, Mary's Bower, Floral Cross, Last Rose of Summer, Vale of Diamonds, Marble Hall, Diamond Grotto, Gem Hall, and Charlotte's Grotto. From any one of these take a single cave flower and examine its

queenly petals, and it will give a good idea of all the rest. Each rosette is made up of countless fibrous crystals; each tiny crystal is in itself a study; each fascicle of curved prisms is wonderful, and the whole glorious blossom is a miracle of beauty. Now multiply this mimic blossom from one to a myriad as you move down the dazzling vista as if in a dream of Elysium, not for a few yards but for two magnificent miles, including all the crystalline region of which Cleaveland's Cabinet is only a portion. Indeed, these necessary names come to seem intrusive and trivial.

All is virgin white, except here and there a patch of gray limestone, or a spot bronzed by metallic stain, or as we purposely vary the lovely monotony by burning chemical lights. We admire the effective grouping done by nature's skillful fingers. Here is a great cross made by a mass of stone rosettes; while floral coronets, clusters, wreaths, and garlands embellish nearly every foot of the ceiling and walls. The overgrown ornaments actually crowd each other till they fall on the floor and make the pathway sparkle with crushed and trodden jewels. It has been impossible to guard all these exquisite formations from covetous fingers, and too many have been smoked by lamps in careless hands. Yet, happily, the subtle forces of nature are at work to mend what man has marred, and to replace by fresh creations what has gone to the mineralogist's cabinet or the amateur's *étagère*.

In secluded chambers, seldom exhibited to the ordinary troops that throng these avenues, may still be seen the trailing vines, branching antlers, stalks of celery, and pendulous fringes like the night-blooming cereus, that were so vividly described by Bayard



Photographed by R. E. Call, 1894.

OULOPHOLITES (Locke).

Curved crystals, etc., from Cleaveland's Cabinet. Forms of gypsum.
Described in the "River Route."

Taylor and other early visitors. These are especially conspicuous in Charlotte's Grotto (named for the wife of Stephen, the guide), and which is near the terminus of Cleaveland's Cabinet. Here are snowy plumes floating from rifts and crevices. And here and everywhere in this matchless fairyland are visible clumps of lilies, daisies, blanched tulips, drooping fuchsias, spikes of tuberoses, glorious chrysanthemums, wax-leaved magnolias—but why exhaust the botanical catalogue? The excited fancy readily finds every gem of the greenhouse and parterre in this crystalline conservatory.

Suddenly, by a startling change, our path climbs up from these lovely regions, ascending a miniature edition of the Rocky Mountains. From the summit of this vast pile of rocks the visitor beholds a lofty hall, which it gives the senior author of this Manual pleasure to name Call's Rotunda, in recognition of the enthusiastic and intelligent researches made by the junior author, R. Ellsworth Call, Ph. D., who is so rapidly making a reputation for himself among speleologists. It is only rivaled in size by the Chief City, described on the Main Cave Route. The transverse diameter of Call's Rotunda is nearly double its largest component, which is the great avenue leading to the visitor's right hand. This avenue leads us for about three hundred yards to a great mass of sandstone debris, where it ends. The explorer is here not far from the surface, as is proven by these sandstone blocks. It is said that at times in this vicinity the rumblings of railroad trains overhead are audible.

Returning to the Rotunda we look down a deep gorge called the Dismal Hollow, more uncanny far than any scene amid the Kaatskills, made famous by

the facile pen of Irving. A black opening in the massive walls admits us to Franklin Avenue, about a quarter of a mile long, and leading to Serena's Arbor, one of the unfrequented but most romantic grottoes of the cavern. Here the walls are studded with inconceivably beautiful botryoidal concretions of lime carbonate. Massive onyx columns reach sheer to the sandstone roof. Water trickles down with perpetual music and finds its way out by crevices in the floor, through which a lamp can be lowered and a glimpse thus be had of other scenes that are rarely explored.

Returning again to Call's Rotunda and taking the left-hand branch, as we are going, we are led directly to Croghan's Hall, a room some sixty feet wide and about thirty feet high. It contains several large stalactites, some of them marred by vandals. The material is translucent and extremely hard; being quite equal to what is commercially known as Mexican onyx. It is a hard carbonate of lime, such as was described by Pliny as alabaster, and the name of "oriental alabaster" is given to it by Dana, to distinguish it from the common alabaster, which is a variety of gypsum, or the sulphate of lime.

On our right is a black and deep pit, called the Maelstrom. It has generally been described as one hundred and seventy-five feet deep; but as measured by Mr. Ben Hains and the writer it is only eighty-eight feet in depth. If it were an open-air well of that depth the descent into it would not be regarded as such a very remarkable feat. But it is quite another thing to go down into a mysterious chasm, yawning amid the rocks, miles from the entrance of this tremendous cavern. Hence it really took a degree of courage, on

the part of Mr. W. C. Prentice, son of the poet-editor, George D. Prentice, of Louisville, to go down thither in quest of adventures. The story was told at the time in the Louisville papers, and was done into spirited verse by George Lansing Taylor, D. D. According to these accounts the young hero was lowered by a stout rope, amid fearful and enchanting scenes, that had never been beheld since creation's morning until brought to view by the faint rays of his solitary lamp. Midway he encountered a waterfall, spouting from the wall, into whose shower he unavoidably swung. At last he stood on the solid rock at the bottom of the pit. On returning to the spot where he had hitched his rope to a stalactite, he found it disengaged and dangling beyond his reach. Ingeniously twisting the wires of his lamp into a long hook, he caught hold again, and then signaled to the guides to draw him up. This they did with such zeal (believe it who may) as to set the cable on fire by friction, so that one of them had to crawl out on the timber across which it ran and pour water on it to extinguish the flame! These embellishments really brought the whole story into discredit. But our investigations recently made prove that Prentice bought the rope in Louisville for the purpose, and that he often narrated his adventures afterward as true. The main fact of his actually descending into the Maelstrom is also verified by guides now living.

According to the guides Matt and William, a certain telegraph operator, Richard Babbit by name, was lowered by them to the bottom of the Maelstrom during Mr. Proctor's management of the cave. Mr. F. J. Stevenson, of London, in 1863, in his letters to his mother, now in our possession, tells the story at great

length of his own descent into this terrible pit, with the help of two guides, Nicholas Bransford and Frank Monbrun, and in the presence of thirty witnesses. On the 15th of May, 1905, Mr. Benjamin F. Einbigler, of New York City, and Mr. John M. Nelson, guide, were lowered by ropes held by Levi Woodson and Edward Hawkins, the rope-length being exactly ninety-seven feet eight inches. Their account, given to me personally, varies materially from the earlier descriptions, and is worthy of unquestioned acceptance. The only way to adjust the differences appears to be by supposing many changes to have taken pace in the Maelstrom during the forty or more years that elapsed between the earlier and later descents. The most that the ordinary visitor will be apt to do, or indeed would be allowed to do, is to peer over the crumbling brink and wonder that any sane mortal should venture down such an awful abyss.

Croghan's Hall is estimated by pacing to be ninety-six hundred yards from the entrance to the Mammoth Cave, and is usually spoken of as its "end." But who can tell where the real termination of so vast a labyrinth may be? At any rate we have more to see before we emerge to daylight.

Accordingly, retracing our steps through the crystalline avenues whereby we approached, we reach Mary's Vineyard, descend again to the level of El Ghor, enter Boone Avenue, and visit what is practically a new portion of the great cavern, although there are signs of its having been explored long ago by unknown visitors.

A well-worn path conducts us to a chasm down whose slope we pick our way to a still lower level and find ourselves in what was described on Stephen Bishop's map, in 1845, as Miriam Avenue, so named for a Jewess, a member of the Gratz family.

Diverging to the right, by a narrow and winding way that returns under Miriam Avenue, and which we named for one of our photographers Pinson's Pass, we presently emerge into a noble avenue named the Martel Avenue, in honor of the famous cave-hunter of France, Edward A. Martel, editor of La Nature, and for many years general secretary of La Societé de Spéléogie, the only society of its kind. The point where we enter it is called, from its singular shape, Bottle Hall. Were we to go toward the left in Martel Avenue we should find the way rugged and difficult; but would be rewarded by a glimpse of Helictite Hall, where are found those curious, twisted, distorted stalactites known as "helictites." Several small passages branch off from this long avenue, beyond which it finally terminates in Galloway's Dome.

The right-hand portion of Martel Avenue soon brings us to the bed of a brook, nearly dry at the time of our visit, but that must at times be deeply covered by swiftly flowing water. Ripple marks of sand alternate with flat masses of jet-black flint. Stranded here and there are visible knots of wood, roots of cornstalks, and other things seeming to have been recently swept in from the surface. Two domes in the vicinity are named Nelson's Domes, for that intrepid explorer, John M. Nelson, formerly a guide, but now residing at Glasgow. Some more early pioneer inscribed the date "1848" on a rock beyond them. Mr. Norman A. Parrish, a professional "steeple-climber," came as far as this in 1904 and wrote me a description of his adventures.

It was reserved for Mr. B. F. Einbigler, already mentioned in these pages, to avail himself of certain footholds over a risky ledge of limestone by means of which he crossed where others had turned back. In his

honor the great overhanging dome is named "Einbigler Dome," and a larger one a hundred yards beyond was named by himself, for his sister, who visited it, the "Edna Dome." This dome differs from most others by growing broader above than it is below, seeming really to open upon some cross-cavern.

On the 15th of May, 1907, Edward Hawkins scaled the wall of the pit underneath the Einbigler Dome; being followed by Einbigler and Bransford. At a later time Mr. H. M. Pinson took in the headlight of an automobile, which was still there on the 18th of June, when I visited the locality with William Bransford and Frank Barry, guides.

Scaling a wall at the end of Hawkins Way, we found ourselves on the level floor of a dome sixty feet in diameter and perhaps two hundred feet high. A lofty gateway opens from it into another dome of equal dimensions, and through similar arches we visit in succession five vast domes arranged as a sigmoidal group. A high window from the fifth dome looks into an irregular room, where a downfall of rocks blocks further progress. In this fifth dome also a waterfall leaps from the apex to the floor, where it vanishes down a chasm. The majestic walls of all the domes rise in horizontal tiers, each tier being about ten feet in thickness and fringed by beautiful stalactites. This mighty masonry ascends in narrowing circles till the searchlight barely enables us to descry the oval white tablet forming the apex, girt by onyx pendants. Vertically the walls are richly corrugated from top to bottom. The entire series of five united domes exceeds four times the magnitude of Gorin's Dome. Ages untold were required for the chemical and mechanical action whereby this surprising

subterranean cathedral was carved in silence broken only by the wild, pattering waterfall or the heavier cataract.

Let me anew express my personal obligation to the Mammoth Cave management for having marked their appreciation of my long-continued and enthusiastic interest in their wonderful cavern by naming, with the approval of the discoverer and the guides, this remarkable group of domes, "Hovey's Cathedral."

A glance at the map will show that Kaemper and Bishop advanced beyond what has just been described, and found two more domes, to one of which Kaemper gave the name of a German lady, calling it "Gerta's Grotto," while the other we have named "Creighton's Dome," for an early and otherwise unknown explorer, whose footprints were found here, and who carved his name on the rocks near by.

There is no way out other than that by which we have come in. Hence we retrace our steps through Martel and Boone Avenues, pause to refresh ourselves at Hebe's Spring, traverse El Ghor, Silliman's Avenue, cross Echo River again by boat, and the River Styx by the natural bridge.

But before ascending to the surface let us make a special trip to the MAMMOTH DOME, which is as wonderful a place as any other in all this marvelous region of silence and eternal night.* In order to do this we enter Sparks' Avenue, named for Mr. C. A. Sparks, of New York City. This avenue begins with Bandit Hall, located at the foot of the Corkscrew. Around us the immense rocks are tossed in the wildest confusion. But the avenue itself is made easy going by the

*The Mammoth Dome is now included in Route I.

removal of obstructions and by the excavation of trenches, where otherwise we should have to stoop. Branches from it are known as Briggs' Avenue and Sylvan Avenue, the latter leading to Clarissa's Dome, where are exhibited the so-called "petrified saw-logs," which are merely prostrated stalactites.

When we first visited the Mammoth Dome, in 1878, we were assured that nobody else had been there for seven years. Tom Lee was our guide, and the account of our adventures appeared in Scribner's Monthly Magazine for October, 1880. It is now reproduced for the reader, with modifications made by consulting notes taken at the time, as well as on subsequent visits.

Barton, my artist, was fascinated with drawing the "Corkscrew"—meaning by this ambiguous term the exit from River Hall bearing that suggestive name. Hence Tom and I went alone through Sparks' Avenue till we emerged on a ledge thirty feet long and ten feet wide, where we were suddenly confronted by a realm of empty darkness. Our four lard-oil lamps were swung in vain aloft and over the edge of the terrace. They revealed neither floor, wall, or roof of that solemn domain. Astonished, I acted on a momentary impulse and told Tom to go back for Barton, more lamps, and fireworks. It was not until Tom's glimmering light had vanished that I realized what a reckless thing had been done. The solitude was dreadful. I sat for a time on the edge of the terrace, amusing myself by throwing ignited oil papers, by means of which I discovered the floor far below me, and also brought to view a rude ladder, with several missing rungs, and blackened by age and decay. My sensations were overpowering, and I pru-

MAMMOTH DOME.
Ruins of Karnak.

dently withdrew to the closer embrace of the narrow avenue and whiled the time away by catching cave crickets, of which there were hundreds. Barton refused to leave until his sketch was done, and accordingly an hour or more passed by before he and Tom joined me, bringing twenty lamps, with plenty of red fire and magnesium.

Carefully descending the treacherous ladder that no foot had pressed for at least seven years, we reached the floor safely. We found that it sloped down to a dismal pool, into which tumbled a cataract higher than Niagara, though of slender size. By burning chemical fires at several points at once we lighted up the huge dome, and estimated its dimensions to be about four hundred feet in length, one hundred and fifty feet in greatest width, and varying from eighty to one hundred and fifty feet or more in height. The walls were seen to be curtained by alabaster drapery, hanging in vertical folds that varied in size from a pipestem to a sawlog; and these folds were decorated by heavy fringes at intervals of about twenty feet.

A huge gateway at the farther end of the hall opens into a room so like the ruins of Luxor and Karnak that we named it the Egyptian Temple. The floor here is paved with stalagmitic blocks, stained by red and black oxides into a natural mosaic. Six colossal columns, eighty feet high by twenty-five in diameter, stand in a semi-circle, flanked by pyramidal towers. The material of these shafts is gray oölite, fluted by deep furrows, with sharp ridges between, the whole column being veneered with yellow stalagmite, rich as jasper, and covered by tracery as elaborate as Chinese carving. The capitals are jutting slabs of limestone, and

the bases are garnished by mushroom-shaped stalagmites. The largest of these we named Caliban's Cushion.

While examining these formations I noticed an opening behind the third column in the row, and clambering down a steep descent reached gloomy catacombs underneath the temple which have since then been more fully explored, but without finding much of interest. On our way back to the terrace we noticed overhead a black opening which Tom assured me was identical with the Crevice Pit in Little Bat Avenue. He also showed me the spot where a rusty lamp was found on the floor of the Egyptian Temple, and that I afterward obtained as a treasure for my cave cabinet.

The story of the Crevice Pit is well worth telling, as originally told by R. M. Bird, M. D., in 1839, and confirmed by later authorities. It seems that Mr. Gatewood convinced the owners of the cave, whose agent he was, that the richest deposit of nitrous earth would doubtless be found under the Crevice Pit. To test this Mr. Wilkins took a rope forty-five feet long and fastened a lamp to it, which he then lowered into the pit. The rope accidentally caught fire, and the result was the loss of the lamp. That was a serious loss in those days, for it could not be replaced short of a trip to Lexington. Accordingly a miner climbed down to a shelf in the ugly black hole and tried to regain his lamp by feeling around for it with his staff. But suddenly the stick slipped from his hand and went rattling down the abyss. Wilkins then offered a reward of two dollars for the recovery of the lamp. A sprightly young negro, named Little Dave, volunteered to be let down, as a sort of animated plummet, to sound the depth of the pit. The story he told on being drawn up

again was so wonderful that nobody believed him. He told of a spacious, splendid dome, bigger than the Rotunda, with tall columns and other magnificent features, now seen by every visitor to the Mammoth Dome. But Little Dave's reward, besides the promised two dollars, was the reputation of being either crazy or the champion liar of Kentucky.

Several futile attempts have been made to ascertain the true depth of the Crevice Pit. Edmund C. Lee, in 1835, tied a stone to a string and "struck bottom at two hundred and eighty feet"; and as Lee was a civil engineer his statement was for years quoted without dispute. In the summer of 1896, Hovey and Call ascertained its true depth. It was not an easy task, owing to the dangerous nature of the opening. First we lowered a light plummet, which lodged after going down about thirty feet. But the weight of the cord kept pulling itself out of hand till one hundred and forty feet had gone down, when the trick was suspected. Probably Mr. Lee was deceived in this way, as many another cave explorer has been. Thus Eldon Hole, in Derbyshire Peak, in England, was measured as being seven hundred and fifty feet deep, when its real depth was only one hundred and eighty-six feet.

Then attaching a lighted lamp to a cord, Doctor all lowered it, while I stood on the opposite edge and watched it go down, calling out whenever it lodged, so that it might be pulled off and started down again. Leaving the lamp there, to be located afterward by going around through Sparks' Avenue to the Mammoth Dome, we next lowered a heavy stone by a cord, making allowanee for stretching. The cord was then measured by a steel tape. The average result of our

several measurements fixed the distance from the brink of the Crevice Pit to the foot of the ladder in the Mammoth Dome as being eighty-eight feet. That point, however, is not the bottom of the dome. Doctor Call afterward measured the remaining distance, and found it to be thirty-one feet, which must be added to the previous figure, making the distance one hundred and nineteen feet. But we must not forget to add the space excavated by the top of the dome above the mouth of the Crevice Pit, and which is certainly as much as thirty feet. Putting all this together, we are safe in asserting that the distance from the highest to the lowest point in the Mammoth Dome exceeds one hundred and fifty feet. This was afterward confirmed by my method of balloon measurement.

Now our steps are turned toward the mouth of the cave. Back we go, through Sparks' Avenue to Bandit Hall. Thence we climb up and up through the Corkscrew till fairly bewildered with its windings. It is a place to test our latent powers of orientation—that marvelous gift that guides the homing pigeons in their vast aerial flights. Professor Brewer and the writer agreed while amid these mazes, and also in other parts of the great cavern, that whenever either said to the other, "Point east," the command should be instantly obeyed. A moment's pause for reflection would spoil it all. But instantaneous obedience was, in frequent instances, rewarded by the pointing of the finger toward the sunrise. Sometimes we would vary the command by bidding each other to point toward the north, and with equally satisfactory results, provided we could trust instinct instead of reason.

Cave animals, hundreds of them, find their way about without guide, map, lamplight, and even without eyes. Dogs lost in the cave invariably find their way out. The writer gave a story of canine adventure in St. Nicholas Magazine for April, 1882, the main facts of which were as follows: Jack, the veteran house-dog, was a cautious brute, who went with us to the Iron Gate, peered between the bars, and then trotted resolutely back to the hotel. Brigham, his frisky comrade, pushed ahead and explored on his own account. One day he ran off after a cave rat, and we had to leave him to his fate. After two days he and Jack were found on opposite sides of the Iron Gate, exchanging experiences. We tracked the path taken by the runaway and found that he had crossed streams, floundered through mud-holes, climbed cliffs, and apparently gone up through the Corkscrew to the Iron Gate, where we were glad to greet him as a hero. He may have been aided by scenting our trail, but we gave him credit for a remarkable gift of "orientation."

Has the earth lungs? And does it breathe? It certainly seems so to us as we finally emerge from the mouth of the cavern. "Antros," the Greek name for cave, simply means "a breathing place," as if through caves, as nostrils, the earth inhaled and exhaled the vital air. Down in the dark recesses where we have been it was almost possible to hear the beating of Nature's heart. The long avenues are the superb arteries through which flows her life. How easy our own respiration has been amid the pure, exhilarating air that comes oxygenated from the central reservoirs of the globe. As we climb upward to the garish light of day we feel the loss of those strong and invigor-

ating atmospheric influences. We almost dread the humidity, the heavy odors, the suffocating exhalations of the weeds, trees, grasses, and flowers. Every visitor is surprised at what he experiences, particularly on emerging from the River Route, where for nine hours he has been stimulated by the oxygenated air. Lingering awhile near the entrance to get used to the yellow sunlight, or the silvery light of the moon, we also grow accustomed to the oppressive atmosphere that sweeps through the Kentucky woods, and which would ordinarily be described as the purest country air.

Finally, breaking away from the fascination of the wide and forever open mouth of the great cavern, that seems to be tacitly inviting us to renew our interior explorations, we cross the rocky platform, the rural road, the vineclad valley, and climb the forest pathway to the crest of the bluff.

THE NATURAL HISTORY OF THE CAVERN. ITS FAUNA AND FLORA

QUITE thirty years passed away after the discovery of Mammoth Cave before the adventurous spirit of Stephen Bishop devised a rude way to cross the Bottomless Pit. Soon after the rivers were discovered, which followed immediately after this daring adventure, the earliest specimens of crayfish and blind-fish were also found. Previous to this time occasional mention was made of the "cave crickets" and the "cave rats," which the miners and early visitors imagined to be the common Norway or domestic rat. That was all.

It is an interesting fact that, with the exception of the blind-fish, the earliest descriptions of animals from the Mammoth Cave were by Europeans. All the American visitors appear to have had little regard for anything except the scenic features of the cavern. But in 1844 there were described two blind beetles, one blind spider, and the blind crayfish, all in a German scientific publication, and by Doctor T. Tellkampf. Two years previously, 1842, Doctor DeKay had described in the Natural History of New York the blind-fish under the name of *Amblyopsis spelæus,* making the Mammoth Cave form, which was then alone known, the type of the genus. Doctor Jeffries Wyman published a minute description of the *Amblyopsis spelæus*, with interesting anatomical details, in 1843. (See Vol. XLV, American Journal of Science and Art, page 94.) But it yet remained for Doctor Tellkampf to still further describe and illustrate this species, his work appearing in the New York Journal of Medicine, July, 1845, with plates

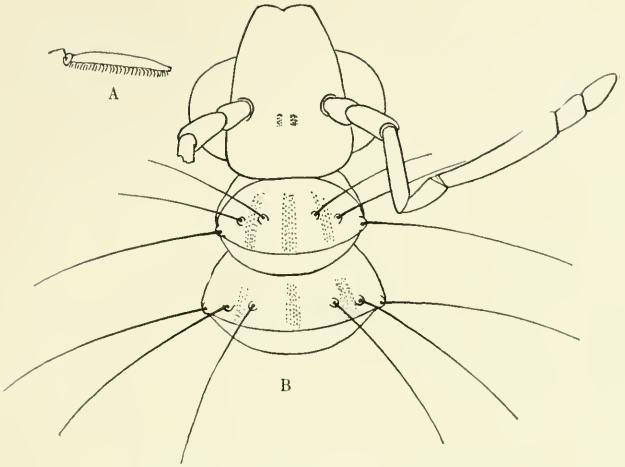
showing the entire fish and its anatomy, constituting the first known illustrations of this form.

It was, however, not until 1871 that very much became known about the various forms of life found in this cave. In the previous year Doctor A. S. Packard and Professor F. W. Putnam had made extensive collections and described them, their work appearing in the American Naturalist in 1871, with excellent descriptions and fine illustrations. Later, two days' active collecting was done in the cavern by Mr. H. G. Hubbard, who published his results in the American Entomologist, Vol. III, in 1880. Numerous shorter papers have appeared, in all about one hundred, in various languages, in scientific journals and the proceedings of learned societies, and these all add a little to our knowledge of the life forms in the cavern.

The most extensive treatise on the animals of this cave is to be found in the Memoirs of the National Academy of Sciences, and is a memoir on Cave Animals of North America, by Doctor A. S. Packard, junior, published in 1889. In this work will be found all accessible information relating to the cavern fauna up to the time of its publication; since then, however, extensive collections made by the writer have revealed a number of new forms which have been elsewhere described and figured.*

The facts connected with these interesting animals are so scattered that it has been deemed of considerable interest to many students to indicate the nature of the forms and the localities where they are likely to be

*See the American Naturalist, Vol. xxxi, pp. 357-392, pls. x, xi, May, 1897; "Some Notes on the Fauna and Flora of Mammoth Cave," by R. Ellsworth Call; also "Notes on the Flora of Mammoth Cave," by R. Ellsworth Call Journal Cincinnati Society Natural History, 1897, Vol. xix, pp. 79, 80.

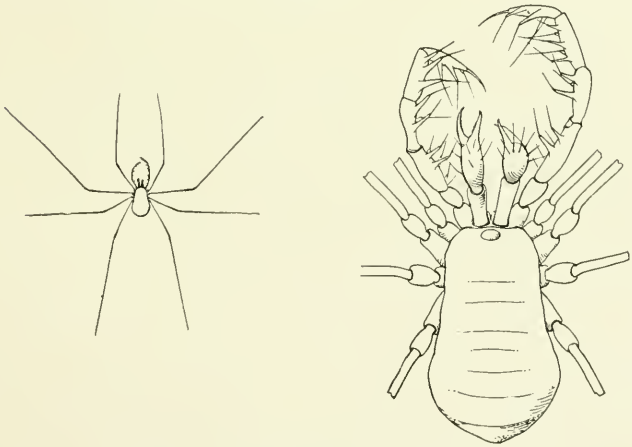


SCOTERPES COPEI (Packard).

Named by Packard for Dr. E. D. Cope, the eminent naturalist.

A. Half the natural size.

B. Enlarged view of head. Eyeless. Showing the tactile hairs on the two anterior segments.



PHALANGES ARMATA (Tellkampf).

A typical, blind, and very ancient cave spider, of the group belonging to the Harvestman, or "granddaddy longlegs." The single eye is abortal. Pigment only remains. The microscope shows that the nerve extending from it to the central ganglia has disappeared.

seen by the visitor. In doing so there has been no attempt at systematic classification beyond indicating the greater zoölogical groups to which the forms belong.

If the visitor desires to collect, permission being secured from the management beforehand, it will be well to remember that the drier portions of the cave will afford him little or nothing save lost time; but in the damper portions of his several trips he may hope to have abundant success. Thus, to instance a few localities, he will probably find specimens of three kinds of flies in and around the decaying specimens of *Coprinus*, which he will find at various places along the River Route. With them, also, will be found occasional specimens of the small brown beetle, *Adelops*. In the Way to Pits and Domes, near Richardson's Spring, he will find historic collecting ground, for this is one of Packard's richest localities. Under the damp flat stones he will here take Tellkampf's small white spider, and that interesting little thysanurid, *Campodea cookei*, described from this place by Packard. Scurrying over the muddy walk or hiding under the flat stones go a number of brown beetles, to which has been given the name of *Anophthalmus*. A little farther on and under the old timbers which are here to be seen will be secured white myriapods, belonging to *Scoterpes*. If the characteristics of the locality be carefully noted, the visitor may be sure that any similar locality will afford him other specimens of the same or other kinds. At the end of Gratz Avenue and in Flint Dome, should the visitor go to that portion of the cavern, in the waters of Shaler's Brook and in the pools in the midst of the dome, he will find myriads of the small

white crustacean, *Cacidotea stygia;* occasional specimens may also be taken in Richardson's Spring.

The larger crustacean, *Cambarus pellucidus,* can be had only in the Echo and connected rivers, though the writer collected two specimens in Flint Dome, until then not known to have any connection with the rivers themselves. Of course Echo River will be, with its pools, the only place where may be found the blind-fish. And neither of these last named forms will prove to be abundant. They are to be collected with great difficulty, even though they may commonly be seen by the visitor as he wends his way along the rivers, on both sides thereof. Occasional specimens are stranded and left in pools which become quite dry on the recession of the waters after a rise. Roaring River, never visited by the tourist, which is a succession of muddy pools for a long distance, is a famous place to collect them, but for these the visitor must arrange with the management.

It is not proposed in this place to review the entire known fauna of the cave nor to list, with descriptions, all of its plants. The casual visitor will have little use for either, because, unless he is a naturalist, and somewhat acquainted with the habits of the animals and plants, he will search long in vain; when he does find their favorite haunts, with few exceptions he will discover that they are rare.

The following list is complete up to the present time, and contains all the species which are certainly known in the cave:

A

B

THE "BLIND BEETLE."
Anophthalmus menetresii (Motsch).

A. Magnified six times, showing tactile hairs on thorax, legs and antennæ. Found in the Labyrinth, Washington Hall, etc.

B. The antenna of Anophthalmus magnified to show more plainly the peculiar development of compensatory sensitive tactile hairs.

BLIND BEETLE.
Anophthalmus.

Their life history unknown, except that their eggs are laid in the sand in the avenue from Lovers' Leap to Lee's Cisterns, near the pool just beyond Gatewood's Dining Table.

A SCAVENGER BEETLE.

Called "Blind," but it has eyes, and bright ones. Found abundantly on and around chicken bones, etc., in Washington Hall and elsewhere. Drawn fourteen times the size of the original.

INFUSORIA.

Chilomonas emarginata Ehrenberg. River Styx.
Chilodon cucullulus Ehrenberg. River Styx.
Monas kolpoda (?). Serena's Bower.
Monas socialis (?). Serena's Bower.

VERMES.

Dendrocælum percæcum Packard. Shaler's Brook; Richardson's Spring.
Lumbricus sp. Banks of Echo River.

CRUSTACEA.

Canthocamptus cavernarum Packard. Wandering Willie's Spring.
Cæcidotea stygia Packard. Flint Dome; Shaler's Brook.
Crangonyx vitreus Cope. Flint Dome; Richardson's Spring.
Crangonyx sp. Shaler's Brook.
Cambarus pellucidus Tellkampf. Echo River; Flint Dome.

ARACHNIDA.

Lælaps cavernicola Packard. Labyrinth.
Gamasus troglodytes Packard. Locality unknown.
Belba bulbipedatus Packard. Labyrinth.
Chthonius packardii Hagen. Mammoth Dome; Labyrinth.
Phalangodes armata Tellkampf. Bottomless Pit; Gorin's Dome; Labyrinth; Mary's Vineyard; Hovey's Ramble.
Anthrobia mammouthia Tellkampf. Labyrinth; Bottomless Pit.
Cælotes juvenilis Keyserling. Locality unknown.
Liocranoides unicolor Keyserling. Labyrinth.
Linopodes mammouthia Banks. Labyrinth.
Rhagidia cavicola Banks. Labyrinth.
Willibaldia incerta Emerton. Labyrinth.
Phanetta subterranea Emerton. Labyrinth.

INSECTA.

Dorypteryx (?) hageni Banks. Darnall's Way.
Smynthurus mammouthia Banks. Darnall's Way.
Entomobrya cavicola Banks. Darnall's Way.
Campodea cookei Packard. All moist stations under stones, especially in Richardson's Spring region; Hovey's Ramble.

Machilis cavernicola Tellkampf. Labyrinth.

Hadenæcus subterraneus Scudder. Everywhere, nearly.

Elipsocus sp.

Adelops hirtus Tellkampf. Numerous stations; especially abundant in Washington Hall.

Anophthalmus tellkampfii Erichson. All moist stations.

Anophthalmus menetresii Motsch. Labyrinth; Washington Hall.

Anophthalmus interstitialis Hubbard. Washington Hall.

Anophthalmus striatus Motsch. Labyrinth.

Anophthalmus audax Horn. Washington Hall.

Sciara inconstans Fitch. Mammoth Dome.

Limosina stygia Coquillett. Mammoth Dome.

Phora rufipes Meig. Labyrinth; Gorin's Dome; Hovey's Ramble.

Scoterpes copei Packard. Labyrinth; Bottomless Pit; Mary's Vineyard; River Hall.

VERTEBRATA.

Neotoma magister Baird. Everywhere; especially abundant in Washington Hall near lunching station.

Peromyscus leucopus Rafinesque. Rotunda.

Vespertilio lucifugus LeConte. Rotunda; Little Bat Avenue; Olive's Bower.

Vesperugo carolinensis Geoff. St. Hil. Audubon's Avenue.

Spelerpes longicaudus Green. Mouth of Cave; Flint Dome.

Amblyopsis spelæus DeKay. Echo River; Roaring River.

Typhlichthys subterraneus Girard. Echo River.

Chologaster agassizii Putnam. Echo River.

MOLLUSCA.

Carychium stygium Call. Mammoth Dome.

This is not an extensive list of animals for so large a cavern, but it is to be remembered that collection is very difficult under the conditions which prevail in the cave. The list, such as it is, results from the occasional work of numerous collectors; an exhaustive and complete study of the fauna has yet to be instituted.

PLANTÆ.

Very much less is known of the plants of the cave than of its animals. Only the most cursory collections have yet been made, though the writer has sought to make complete the collections of microscopic forms. Many of those collected were indeterminate, and others are yet undescribed. This will, in a measure, account for the meagre list.

It should be remarked in passing that with but two or three exceptions the forms found are all such as occur on the surface of the ground, and all are fungi or related groups. The list now following contains all certainly known at this time:

Coprinus micaceus Bull. River Hall only. Groups of this toad-stool are sometimes found along River Hall, near the boat landing, and at the Cascades, near the River Styx.

Fomes applanatus Pers. Labyrinth.

Rhizomorpha molinaris. Abundant on old timbers in Mammoth Dome. Probably, like its foreign relatives, this form will be found to be phosphorescent.

Microascus longirostis Zukal. Washington Hall.

Zasmidium cellare Fr. Corkscrew, at top, on old barrel head.

Mucor mucedo Linn. Labyrinth; Mary's Vineyard; River Hall.

Gymnoascus setosus Eidam. Washington Hall.

Sporotrichum densum Link. On dead crickets.

Sporotrichum flavissimum Link. Washington Hall.

Laboulbenia subterranea. On Anophthalmus.

Cœmansia sp. Washington Hall.

Papulospora sp. Washington Hall.

Bouderia sp. Washington Hall.

The great number of forms from Washington Hall is to be explained by the fact that in that locality may be found a great mass of refuse from dining parties;

on the rejectamenta of lunches many varieties of minute fungi occur, though the spores are quite likely introduced by visitors and in or with the food. A single very small but beautiful *Peziza* occurs on the timbers in Mammoth Dome, but is certainly introduced from without. The same fact is true of amorphous forms of *Fomes applanatus* taken from bridge timbers in the Labyrinth.

BLIND ANIMALS: THEIR ENVIRONMENT AND DEVOLUTION.

SINCE Doctor Call prepared his admirable chapter on Cavern Fauna and Flora a few early accounts have come to light, and some recent additions have been made to the literature on the subject, especially concerning its bearing on the theory of evolution.

The very first account ever published about the eyeless fish was by Rev. Robert Davidson, D. D., President of Transylvania University, in a small volume from the press of A. T. Skillman, Lexington, Kentucky, 1840, entitled, "An Excursion to the Mammoth Cave, and the Barrens of Kentucky." Stephen Bishop had just crossed the Bottomless Pit and discovered what was then styled simply "The River," in whose sullen waters were found very remarkable "white fish without eyes, but with their other senses so acute that the slightest touch of the water overhead was sufficient to alarm them, and make them dart off like lightning." In 1842 W. T. Craige gave a single specimen of the blind fish to the Philadelphia Academy of Natural Sciences; and in that same year DeKay described it in his volume on Reptiles and Fishes (p. 187) in the Natural History of New York. He named it the *Amblyopsis spelæus,* meaning weak-eyed cave dweller. This was soon followed by articles by Wyman, Thompson, and Tellkampf. *Typhlichthys subterraneus* was first described by Girard in 1859; the *Chologaster agassizii* was described and named by Putnam; and the *Troglichthys roscæ* was thus named by Eigenmann. These four genera: *Amblyopsis, Typhlichthys, Chologaster,* and *Troglichthys,* are grouped as a family, under the name of *Amblyopsidæ,* and belong to

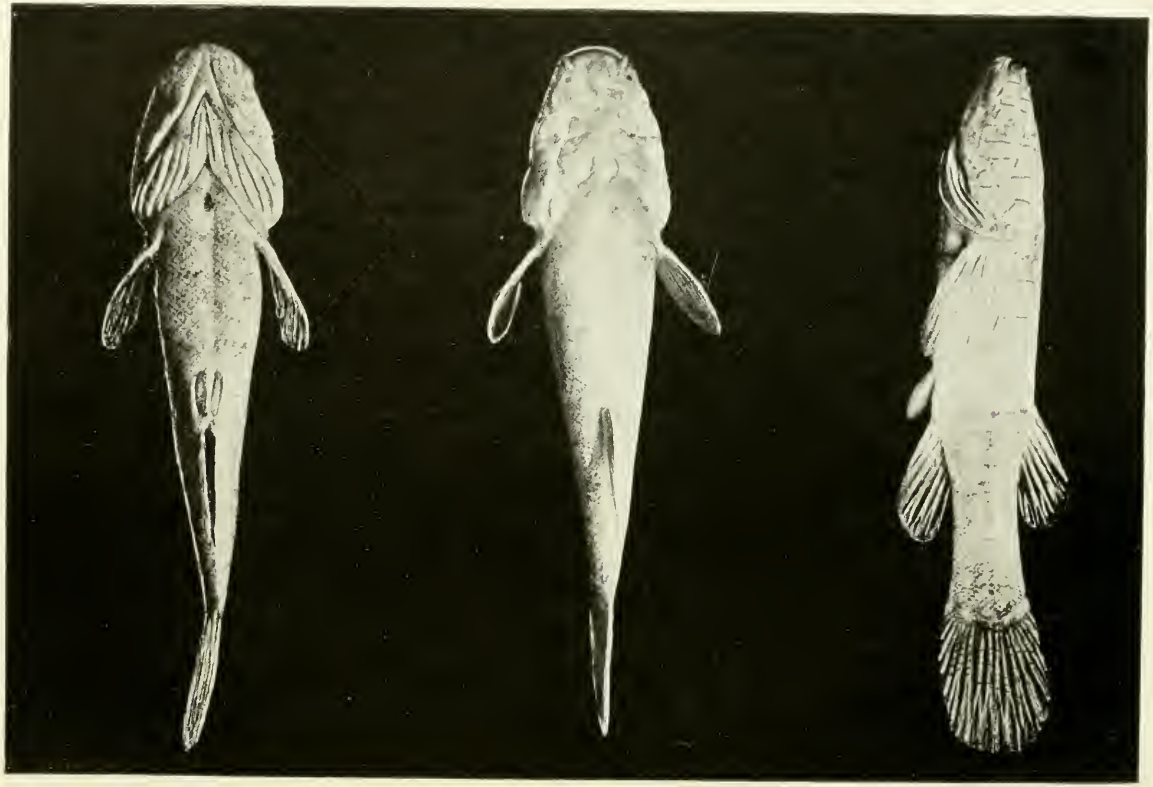
the order of *Haplomi*. (E. D. Cope, Proceedings of A. A. A. S., Indianapolis, 1872, pp. 328, 333.)

These, and certain other true subterranean fauna, may be regarded as mainly of Pleistocene origin; while a few are supposed to be remnants of Tertiary, or possibly of Cretaceous life.

Their strongly marked divergence from similar creatures found in open waters convinced the elder Agassiz that they were "specially created for the limits within which they dwell." This question will receive further attention later on.

Insignificant as cave animals may seem to the careless eye, these lowly minnows, crawfish, worms, flies, fleas, spiders, crickets, and beetles have been microscopically examined, dissected to their minutest anatomy, and laborious treatises written about them, bristling with words big enough to describe whales, mastodons, and mammoths. Indeed they have a voluminous bibliography, including contributions by Agassiz, Banta, Blatchley, Chilton, Cole, Cope, Collet, Cox, Dubois, Eigenmann, Forbes, Garman, Girard, Gunther, Hamann, Hay, Holmes, Hubbard, Jordan, Lankester, Nagel, Packard, Parker, Payne, Putnam, Richardson, Semper, Viré, Yerkes, and others, besides the authors of this Manual.

The average size of a full-grown *Amblyopsis spelæus*, the most famous of the blind-fish, is only about three and a half inches. Rarely it is found longer, and the Mammoth Cave guides tell us of specimens measuring eight inches. The writer never saw one that exceeded five inches in length. He is inclined to think that stray visitors from the surface waters have been sometimes mistaken for the true *Amblyopsis*. The blind-fish are found in pools, or the rills between the pools, and often



AMBLYOPSIS SPELÆUS (Side, dorsal and ventral view.)

in deep wells in the vicinity of caves. They are dignified denizens of the darkness, often lying quietly on the muddy bottom of the waters, floating lazily on the surface, or slowly swimming along by the aid of their pectoral fins, though bringing the tail into action when disturbed, and darting rapidly away.

What do cave creatures live upon? The question of food supply is always of prime importance. An animal with plenty to eat is apt to grow and unfold its organic life, whereas one half-starved will be likely to have its growth retarded, and certain features and functions changed or discontinued.

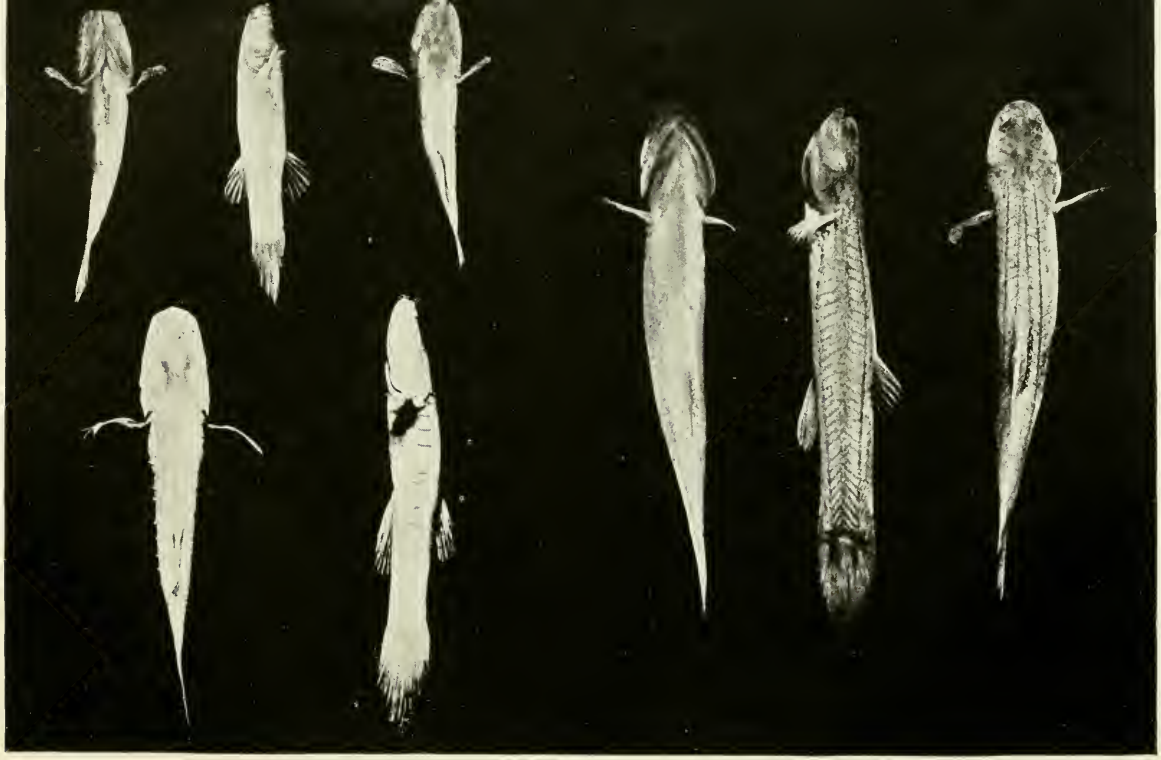
Clearly strict vegetarians must be scarce in caverns because of the general paucity of vegetable life. Still, where there is some such matter, it is utilized. Cave crickets, centipedes, and myriapods, like the *Pseudotremia* and hairy *Scoterpes*, are known to live on the debris of leaves and wood, swept in annually by the overflowing streams. The cave carnivora are scavengers, subsisting on dead bats, rats, and refuse dragged in by beasts or left by human visitors. The cave crawfish (the *Cambarus pellucidus*) feeds on aquatic crustacea which it deftly extracts with its pincerlike claws from under flat stones. The blind-fish catches the young crawfish when it can, and eats its eggs, preying also on the *Crongonyx* and other crustacea, and, we regret to say, on minnows of its own kind. We have known one instance where a blind-fish caught and swallowed a fish that had eyes and ought to have known enough to escape. And, such is the conformity to conditions where plenty is the exception and scarcity the rule, that I have kept blind-fish for a whole year in an aquarium where there was no other food than the animalculæ and con-

fervæ growing in the water. Experiments of naturalists lead to the conjecture that the blind-fish are aided in search for prey by certain terminal buds on the snout, the head, and on the body.

All observers agree that, when in captivity, the blind-fish thrive best in the dark. They are certainly sensitive to the light, though sightless. When placed in a trough partly covered and partly exposed to the light, they instinctively prefer the darkened portion of the trough. Eigenmann made a series of interesting experiments, not only in aquaria with blackened tunnels and partitions, but also in those that were illumined by the various colors of the spectrum, in order to see what reaction might follow. His conclusion was that the blind-fish strongly prefer red and shun blue.

Sloan, Packard, Blatchley, and others agree with our own observations as to the torpidity of the organs of hearing in blind-fish, although it is said that "the auditory spots" exist in them just as in fish in open streams. Eigenmann says that "blind-fishes detect vibrations with a frequency of one hundred per second, by means of sense organs in the skin." He adds very curious remarks as to the amatory contests in which the rival males vigorously punch and thrust each other while they quarrel for their mates.

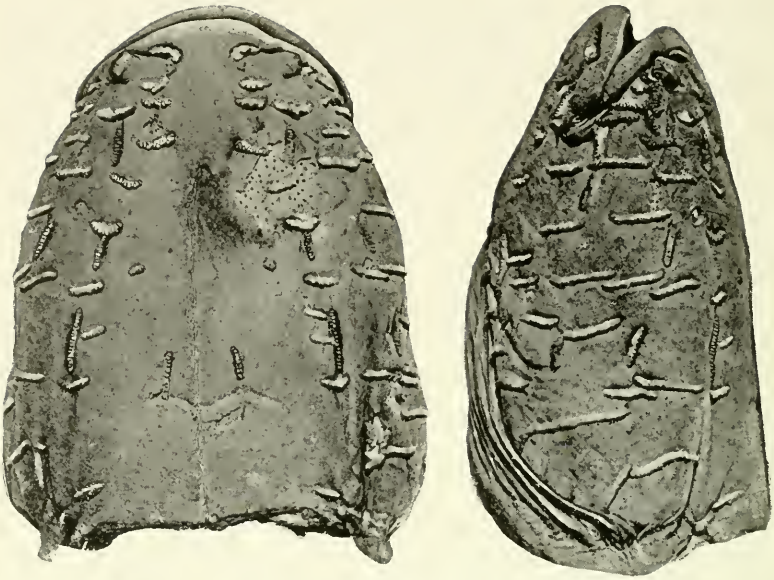
A general but erroneous notion prevails that the *Amblyopsis* is viviparous. An instance is often quoted in which an adult fish was left alone in an aquarium and the next day was found with eight little ones. The explanation is that the young remain for about a month in the maternal gill pouch after being hatched from the egg, where they had previously been for about twenty-eight days.



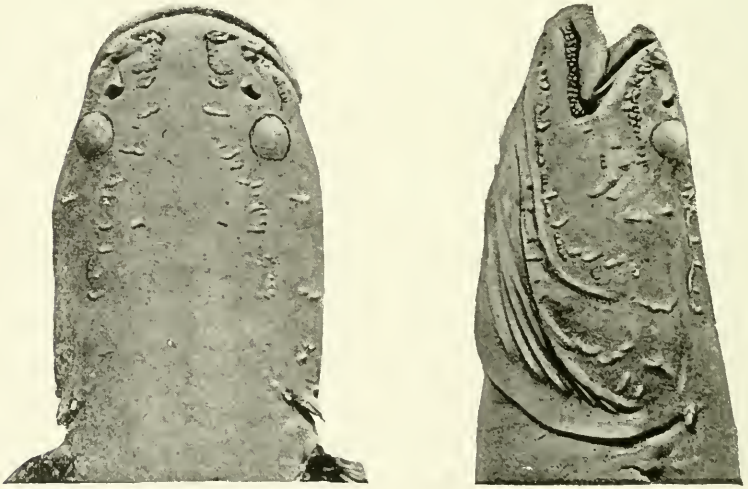
TROGLICHTHYS ROSÆ
(Dorsal, side and ventral view).
TYPHTHLICHTHYS SUBTERRANEUS.

CHOLOGASTER AGASSIZII
(Dorsal, side and ventral view).

Photo by Eigenmann.

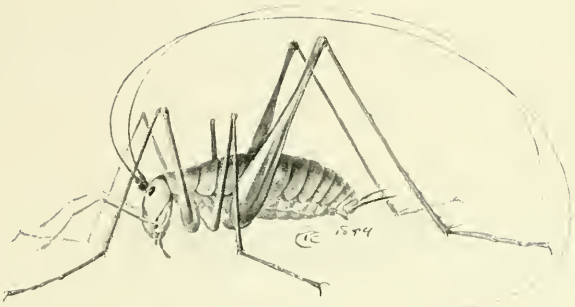


HEAD OF TYPHLICHTHYS SUBTERRANEUS.
(Mammoth Cave.)



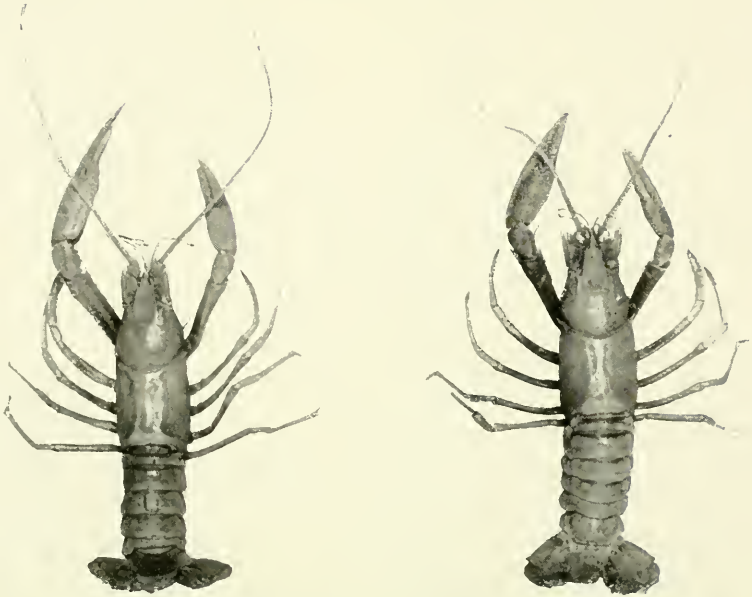
HEAD OF TYPHLICHTHYS OSBORNI.
(From Horse Cave, near Mammoth Cave.)

Photo by Eigenmann.



HADENŒCUS SUBTERRANEUS (Scudder).

A cave cricket—not grasshopper, but of the katydid family of Orthoptera. The pigmental eyes are sightless. The thorax is still somewhat brown, showing that the bleached condition observable in most cave animals has not yet been hereditarily established. Observe the extraordinary antennæ, as an instance of compensation.



Male

Female.

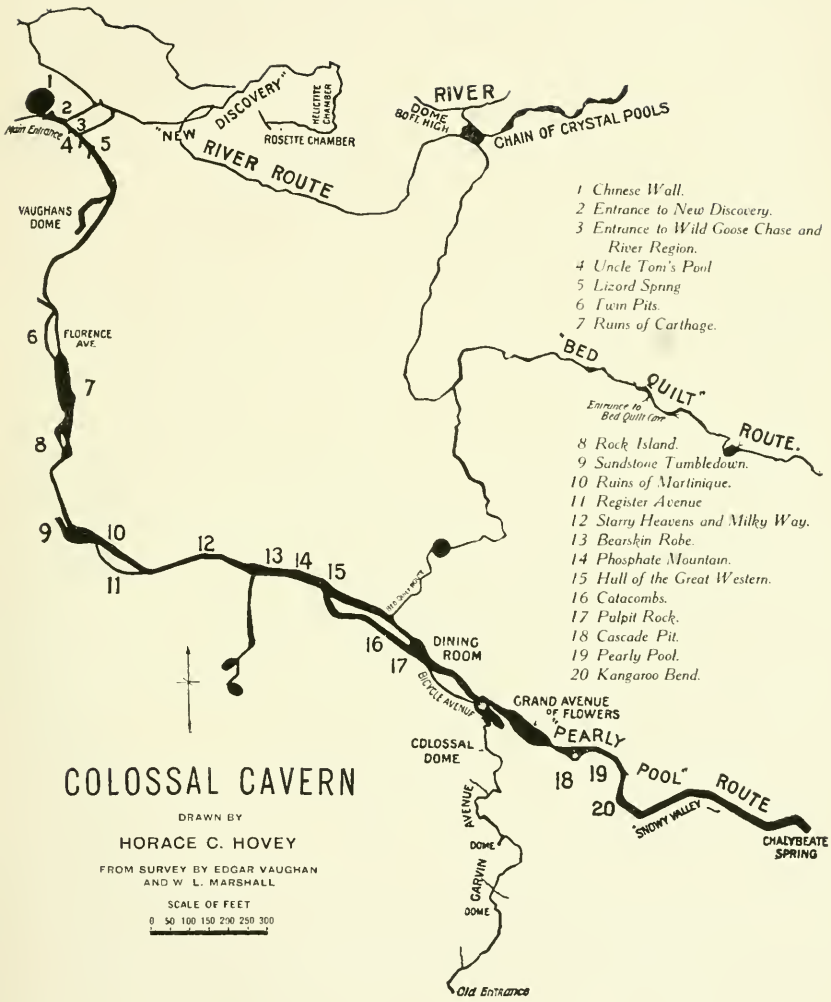
CAMBARUS PELLUCIDUS (Tellkampf).

As early as 1856 the writer visited certain romantic caves along the valley of the White River, near Mitchell, Indiana, where he saw blind-fish and blind crawfish, which he also observed in other Indiana caves. More recently the Mitchell caves have come into notice through the researches of Professor Carl H. Eigenmann, of the Indiana State University. Doctor Eigenmann began to give attention to subterranean fauna in 1886, and ten years later visited the Twin Caves and Dalton's Spring, at Mitchell, where he found abundant material for his biological laboratory. In 1893 the State Legislature put about one hundred and eighty-two acres of the land around these caves in the keeping of the trustees of the University, at his suggestion and to further his researches and experiments. Thus encouraged, and also aided by grants from scientific societies, most valuable materials have been obtained, as well as from various other caves in Indiana, Kentucky, Tennessee, and elsewhere. The results were made public by a number of papers read before scientific societies, and in bulletins from the University. In 1909 these were collated, with much new matter, and published, as a quarto monograph, by the Carnegie Institution of Washington, under the title, "Cave Vertebrates of America—a Study of Degenerative Evolution; by Carl H. Eigenmann, Professor of Zoölogy, Indiana University." This exhaustive work comprises two hundred and forty-one pages, with thirty-one full plates and seventy-two text-figures. It deals with cavern fauna as found all over the continent, from California to Cuba; but the main part of the work concerns blind vertebrates and their eyes, describing twelve varieties, eight of them belonging to the *Amblyopsidæ*. Only seven hundred copies were printed, and hence the volume is not generally accessible.

It is no new idea that subterranean life is highly instructive concerning the theory of evolution, the writer himself having repeatedly spoken on the subject before scientific societies. Evidently, if degeneration or devolution follows as the result of the seclusion of certain kinds of plants and animals in dark caverns, it must be by the withdrawal of forces and causes that, under favorable environment, would work for evolution. For example, if we discover the partial or total absence of certain muscles, nerves, or organs, as the result of degeneration carried on for many generations, the inference is fair that these atrophied parts would be duly evolved again were the process reversed and the cave animals to live for a sufficiently long period under the same conditions as their open-air congeners, in the sunlight and with abundant food.

Every one has noticed how potatoes and turnips put forth colorless shoots when growing down cellar. It is even possible to raise a crop under such conditions; but the tubers are small and waxy, showing depauperation. Imagine the process to go on for years or centuries, and the result might be a plant hardly to be recognized by comparison with the vegetables growing in the garden. Just as aquatic plants in cave waters are bleached, so with the true cavern fauna. The crawfish and crustaceans are white, or at best a pale brown. So with the blind-fish, the myriapods, the spiders, etc. Exceptions excite suspicion. Cave flies, for instance, which are a dull black, are able to fly in and out with occasional access to the open air.

Plainly natural selection, or self-protection by choice of coloration, can not explain the cave-bleaching for animals dwelling in perpetual and utter darkness. The bleaching seems simply due to the atrophy of those cells


1
2
3
4
5
Main Entrance
"NEW DISCOVERY"
HELICITE CHAMBER
ROSETTE CHAMBER
"NEW RIVER ROUTE"
RIVER
DOME 80 FT. HIGH
CHAIN OF CRYSTAL POOLS
VAUGHANS DOME
6
FLORENCE AVE.
7
8
9
10
11
12
13
14
15
16
17
DINING ROOM
BICYCLE AVENUE
GRAND AVENUE OF FLOWERS
"PEARLY POOL" ROUTE
18
19
20
SNOWY VALLEY
CHALYBEATE SPRING
COLOSSAL DOME
AVENUE
DOME
GARVIN
DOME
Old Entrance
"BED QUILT" ROUTE.
Entrance to Bed Quilt Cave
1 Chinese Wall.
2 Entrance to New Discovery.
3 Entrance to Wild Goose Chase and River Region.
4 Uncle Toni's Pool
5 Lizard Spring
6 Twin Pits.
7 Ruins of Carthage.
8 Rock Island.
9 Sandstone Tumbledown.
10 Ruins of Martinique.
11 Register Avenue
12 Starry Heavens and Milky Way.
13 Bearskin Robe.
14 Phosphate Mountain.
15 Hull of the Great Western.
16 Catacombs.
17 Pulpit Rock.
18 Cascade Pit.
19 Pearly Pool.
20 Kangaroo Bend.
COLOSSAL CAVERN
DRAWN BY
HORACE C. HOVEY
FROM SURVEY BY EDGAR VAUGHAN AND W. L. MARSHALL
SCALE OF FEET
0 50 100 150 200 250 300

in which, under the stimulus of light, pigmental matter is secreted.

The blind-fish furnish a typical example of *panmixia* (a term literally meaning "all mixed up"). We can imagine the first colony, captured by some catastrophe in underground waters, to have had their eyes simply weakened by disuse. In following generations the eyes would be shrunken and useless. This might begin by individual degeneration (ontogenetic panmixia); and then racial degeneration (or phylogenetic panmixia) would follow. Fish with atrophied eyes would transmit blindness to broods of young fish till a blind fauna was established.

Let us note with almost pathetic interest the compensations given to the cave animals by Him who marks the sparrow's fall. This feature of evolutionary work has hardly had the attention it deserves. In cave insects, spiders, and crustacea the form is elongated till in some cases it is truly grotesque. Many a time I have held a burning candle so near a cave cricket as to stop for fear of setting it afire; and the experiment was regarded by it with indifference. But the least finger-touch of one of its extremely elongated and sensitive feelers, delicate as a spiderweb, would give the alarm, causing it to run away with ludicrous celerity. Cave beetles find their compensation in long stiff bristle-like hairs, so that they move about with remarkable facility. We have kept in the same tank the common crawfish (*Cambarus Bartonii*) and the blind crawfish (*Cambarus pellucidus*) and observed their habits of feeding. A morsel thrown to the first would be seized and disposed of at once. But if dropped near the blind creature it would dart back and wave its long feelers, only approach-

ing the morsel by a series of cautious strategic movements. Do not forget this beneficent law of compensation. Let us not lay too heavy a load on favorite theories, which certainly do account for many, but not for all things. Evolution is limited by environment and its process may even be reversed and become devolution. Let us not hurry. We are not like a sworn jury that must find a verdict and be discharged. There is plenty of time. Wait and investigate. Pigeon-hole every fact, and wait.

The best definition of evolution describes it as a continual differentiation of the complex from the simple. First, simple forms; then the complex. But in cave fauna we find the process reversed; the complex forms are reverting to those that are more simple. Our limits forbid our either following further such fascinating problems, or taxing the reader's patience by moralizing. Yet we may affirm anew our cherished faith that all forms of life exist and go on under a Divine plan, whether by progression or retardation, by deprivation or compensation, by evolution or devolution, environed by darkness or light, amid profound caverns or amid the brave sunshine. Many things beyond our immediate comprehension are worthy of patient and prolonged investigation. We may close this chapter by quoting the oft-quoted words of the former poet-laureate of England:

"Flower in the crannied wall,
I pluck you out of the crannies,
Hold you here, root and all in my hand,
Little flower: but if I could understand
What you are, root and all, and all in all,
I should know what God and man is."

Vaughan's Dome.

Grand Crossing.

THE COLOSSAL CAVERN

By HORACE CARTER HOVEY

IN the vicinity of Mammoth Cave are numerous smaller caves and grottoes, each with its peculiarities and attractions. One of these has the odd name of the Bed-quilt Cave, due it is said to the fact that an Indian quilt was once found there. No particular interest was taken in it until recently. No one knew that it led to one of the most magnificent caverns in America till after the latter had been otherwise discovered.

The late Mr. William Garvin, a veteran soldier and guide through the mazes of the Mammoth Cave, told the writer that, on the 15th of July, 1895, he observed a hole in a hillside adjoining his own farm. Entering it he made his way into a large dome, of which the hole was the apex. Bringing ladders, he and his neighbors climbed down for sixty-six feet to the floor of the dome, whence they pursued a winding way amid the rugged rocks in a northerly direction for some twelve hundred feet, passing numerous objects of interest. Finally they were brought abruptly against a vertical wall, whose floor was visible thirty-six feet below where they stood. By means of their ladders they climbed down to the bottom, and noted the five projecting points that suggested to the writer the name of the Quinque Dome.

An article over my signature appeared in the Scientific American August 29, 1896, ascribing the first exploration to a young man named Pike Chapman. The discovery has also been claimed for Robert Woodson, who is said to have found it while searching for a spring. Possibly there were several simultaneous discoveries; but we give full credit to the statement made to us per-

sonally by Mr. William Garvin. All the original entrances have been wisely closed up by the present owners, partly to prevent spoliation and partly because the natural openings were hard to reach and for other reasons inconvenient.

In January, 1896, the Louisville & Nashville Railroad Company purchased what is well named "The Colossal Cavern" from the late Dr. L. W. Hazen, on whose farm the first known entrance was located, and for a time they employed him as their agent. As further explorations were pushed in various directions, the Company bought all the land under which its course was found to run, and expended large sums in widening narrow passages, smoothing rough places, building stairways where these were desirable, and did many other things for the comfort of visitors. On their special invitation the writer visited the Colossal Cavern in 1903, and made a map of it from the notes of a survey by Edgar Vaughan and W. L. Marshall, which has been extensively used in the railroad advertising brochures, and appears also along with a descriptive article by me in the Scientific American Supplement, November 21, 1903, parts of which have been published by others without giving the author due credit. (See also my article in Volume VI of the eleventh edition of the Encyclopædia Britannica.)

On the occasion of my visit the first use was made here of individual acetylene lamps, by whose aid the writer did some fairly good work in subterranean photography, the results being published at the time. I was accompanied by the noted archæologist, Mr. Gerard Fowke, and our guides were Messrs. J. M. and Morris Hunt, to whose kind attentions we were much indebted.

So accurate was the instrumental survey already re-

Samson's Pillar.

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ferred to above, that by its means the Company found themselves able to force a new entrance at a locality where it was most desired by themselves; and this is now the only mode of access to the cavern. It is at the foot of a steep hill, facing the west, and located a mile and a half from the entrance to the Mammoth Cave. The road thither winds along the margin of Eden Valley, into which it presently descends. Both this and the nearby Doyle Valley are true "sink holes" of great magnitude, with groves, farms, and habitations, but without running water, though gathering volumes of water during rainfalls, to empty them through pits into caverns underneath. Where these orifices have been closed up there are now ponds, with reeds and rushes.

The entrance to Colossal Cavern, being wholly artificial, has no special beauty, but is simply a convenient door and stairway, in passing through which we notice the outward draft of air that extinguishes our lamps, to be relighted when fairly underground. The rock from which the cave is excavated is limestone of homogenous texture. Midway down the stairs we step aside to inspect what is termed the Chinese Wall, which forms the rim of a pool in a room about one hundred feet in diameter. Small stalactites cover the ceiling, and there are numerous stalagmites, one of the largest of them being named the Pagoda, from its fancied resemblance to an Eastern temple of that description.

Some two hundred feet within, a path diverges to the so-called "New Discovery" and to the closed entrance from the Coates farm. Still beyond it is a rambling way that is known as the Wild Goose Chase, because it seems to get nowhere.

On our right, as we proceed in the main cave, is Uncle Tom's Pool, where we found the only specimen that we saw in the cave of the blind crawfish (*Cambarus pellucidus*). We were assured, however, that blind fish and other cave fauna abounded in the river region; and we saw in various parts of the cave blind beetles, flies, spiders, and crickets.

On our left, one hundred and fifty feet beyond Uncle Tom's Pool, we were startled by seeing on the brink of a spring what looked like a great lizard, but which proved to be only a grotesque mass of metal-stained flint, three feet long, like a lizard in bronze. We named the canopy over it the Saurian Dome. Near Armstrong Pit and the Horseshoe Dome we observed many geodes in the wall, enclosing crystals of quartz and calcite. We also found fossil corals, known as "*Zaphrentis*," having value in determining the geological horizon of the limestone.

In 1898 Mr. Edgar Vaughan crawled through a small hole on the right, distant some five hundred feet from the entrance, and found that it opened into an enormous dome, now bearing his name. This narrow opening has been artificially enlarged for easy access to Vaughan's Dome, which by careful measurement is twenty-six feet wide (at one point forty feet), three hundred feet long, and by balloon tests seventy-eight feet high. The balloons used by Mr. Maypother in making this measurement were inflated by hot air, which is a better method than by hydrogen gas, besides being less expensive. The first balloon released shot to the roof like a rocket, striking with such force as to careen and catch fire, burning the retaining cord. Later experiments, more carefully made, were perfectly successful.

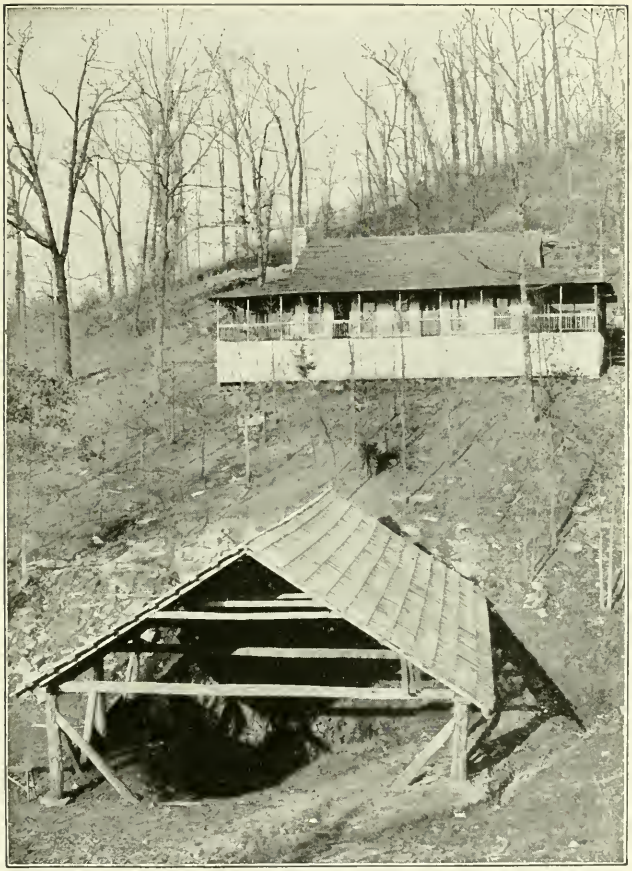
At Grand Crossing the main cave is crossed by Florence Avenue, on a lower level, after running parallel with it for several hundred feet. This avenue has highly decorated walls. Midway in it are the Twin Pits, into one of which falls the Musical Shower, a cascade with remarkable reverberations. Florence Avenue enters the main cave at the Grand Galleries. Along the walls are many gypsum formations, resembling various kinds of flowers. Beyond the Lovers' Gallery, four hundred feet long by thirty feet wide, is a still grander enlargement, styled the Ruins of Carthage, resembling the demolished walls and battlements of a great metropolis. Taking into consideration the dimensions of this vast hall, four hundred feet long by one hundred feet wide and thirty feet high, then noting the fact that its nearly flat ceiling is one immense block of limestone, and reflecting on the additional fact that above it is an immense mass of rocky strata, upholding forest trees, we wonder how such a flat roof can support such an enormous superincumbent weight. The only object that looks at all like a support, though it can not properly be so regarded, is what is called Samson's Pillar, thirty feet in diameter, near which the roof curves into an arch.

In this vicinity we saw many fine saccharine incrustations, as if some candy-maker had flung cartloads of gum-drops and other confectionery against the walls. Faces and figures, some lovely and others grotesque, stand out from nooks and corners in startling relief. One that is especially lifelike is known as Alice Ringgold's Face.

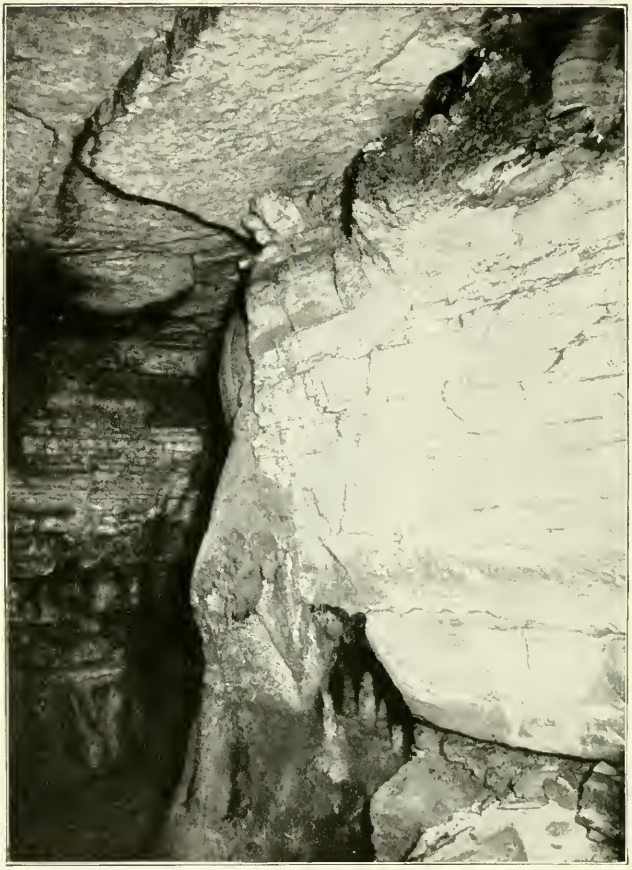
A huge rock on our right, just beyond Samson's Pillar, has a remarkable resemblance to the stern of an

ocean steamer with her rudder hard aport, though unshipped, and is an almost exact reproduction of a formation in the Mammoth Cave known as the Great Eastern. Tremendous forces have been at work, as is proved by the Ruins of Martinique and the Catacombs. We measured an enormous block, sixty feet long by twenty feet wide and ten feet thick, like the sarcophagus of an ancient Goliath of Gath. At a point two thousand feet from the entrance is a tumble-down called the Sandstone Mountain, where the cave cuts through the St. Louis limestone to the overlying Chester sandstone. It is said that the top of this mountain is only twenty feet below the surface of the earth. On the wall near by we saw an exquisite branching variety of the coral known as *Tubipora*, sixteen inches long by six wide. A number of interesting objects have been passed in reaching this point; among which may be mentioned the Everett Rock, fallen from above and leaning against the wall; Table Rock, at the foot of Sandstone Mountain, and several other detached blocks here and there, indicating the possibility of some shock as of an earthquake, or other tremendous force, that hurled them down.

Thus far we have gone in a southerly direction; but now we turn almost due east for some fifteen hundred feet and note what we can find. Beyond the spacious Auditorium is Register Avenue, where visitors are allowed to inscribe their names, as in a rocky album. At the Phosphate Mountain—where the original owner made experiments, only to find that it was a false phosphate—the cavern divides around a so-called "island" six hundred feet long, near whose farther end begins the "Old Bed-quilt Cave" already mentioned, and that stretches away to the northeast for one thousand five



Entrance to Colossal Cavern.



Henry Clay Monument.

hundred feet and then turns westward for the same distance, thus making the surveyed portion three thousand feet in all, though often given as having a much greater length. In it are pits, domes, tumble-downs, and various more or less interesting formations; but it is not included in the route over which visitors are usually taken.

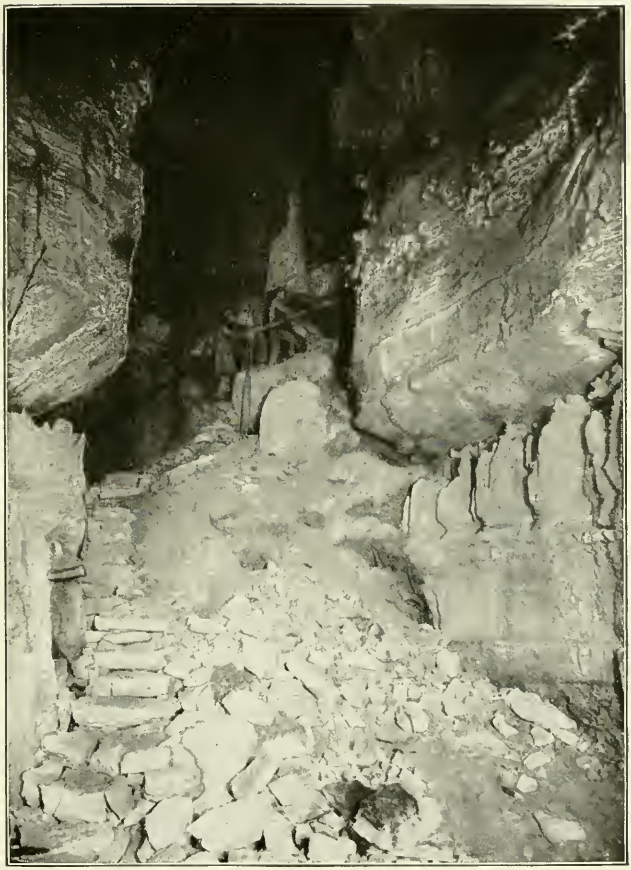
At the termination of the Long Island is the Pulpit on one side and the Dining Room on the other. The ceiling of the Dining Room is the native rock, as smooth as if finished by trowel and float; a board floor is laid over the sand, and there are tables and benches for the accommodation of those who wish to lunch. Beyond is the Bicycle Avenue, trending to the right for three hundred feet and then rejoining the main cave.

The crystalline formations are wonderful. The roof under which we are now passing is spangled with efflorescences that mimic the starry heavens, with here and there a comet or a meteoric shower. Gypsum crusts sometimes hang from above in sections several yards square, seemingly ready to drop if jarred. Both straight and curved crystals of selenite abound, the latter known as "oulopholites." So many and splendid are they in one hall as to cause it to be named "The Grand Avenue of Flowers." On the walls single spikes six or eight inches long are frequent, and here and there we find a branching mass one or two feet long, like crystal stag-horns. Delicate lacelike webs are spread between clusters of flowers. The Bear-Robe looks like a mass of fur spread on the wall to dry; but we find it made up of hundreds of crystals of selenite whose tips are stained by some black mineral, and the body of the mass is a soft grey. There are also fine botryoidal, or grapelike, clusters.

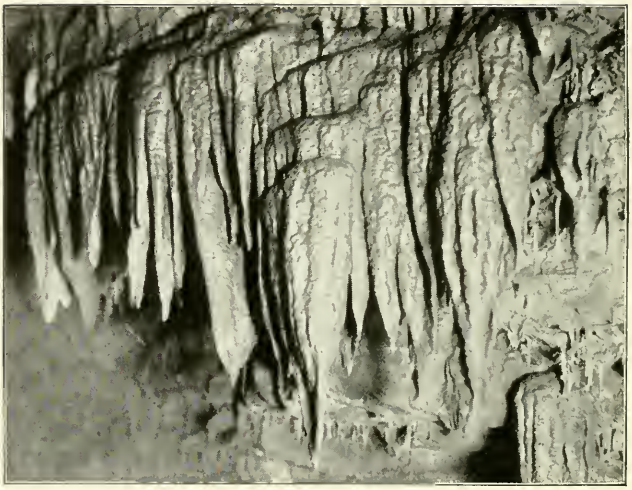
Strange enlargements and ramifications of the cavern now come to view, with here and there a window-like opening into ghostly chambers whence weird apparitions seem to beckon to us. Wonders crowd upon us. Climbing a steep acclivity, the highest elevation in the cave, whence a ladder connects with a short passage leading to a bridge across the apex of an enormous dome whose floor lies one hundred and thirty-seven feet below, we drop fireballs, by which the walls are illuminated as the masses of flame gyrate to and fro. Formerly daring adventurers were lowered by a windlass to the bottom of this mighty dome; but now there is a less dangerous way.

We descend a flight of steps and pass through a gigantic gateway, twenty feet wide and sixty feet high, whose right-hand support is the largest stalagmite in the cavern, its height being fully eighty feet. The writer suggested for this noble shaft the name of the Henry Clay Monument, and the name was approved by the management. On the left of the gateway is the finest example of the synclinal it has ever been my lot to see below ground. The thick strata above had to yield to the enormous pressure brought upon them, and were thus crushed into the reversed arches that we behold.

Passing reverently through what reminded me of the famous Redeemer Gate of the Kremlin at Moscow, we descend still farther by stone steps that wind around the base of the huge alabaster monument named for Kentucky's matchless orator and statesman, and suddenly find ourselves in what seems like an open space, while aloft and around us is utter darkness. The guides tell us that we are at the lowest level of the cavern, two hundred and forty feet vertically lower than the original



Entrance to Colossal Dome.



Above Pearly Pool.

entrance. Our torches do little more than to make the darkness visible. Our acetylene lamps cast rays of light across to the wall, fifty-six feet distant, but flash upward in vain. Burning magnesium ribbon, with which every cave-hunter should be supplied, and that can be ignited by a simple match, we catch a glimpse of the apex of what has fitly been named the Colossal Dome, the grandest room in all this region of silence and of night.

An ingenious method of illumination has been devised by Mr. Hunt, making use of the old windlass whereby men used to be lowered, as already related. The rope has been removed, but a cord takes its place, both ends of it being lowered to the floor. To one end was fastened a wire holding a fire-basket, in which were put oiled rags, chemicals, and a quantity of magnesium ribbon. Then, igniting this mass of combustibles, we pulled on the other end of the long cord, thus hoisting the huge fireball to the apex. This made visible the snow-white fungus, many feet long, waving from the timbers of the decaying bridge. The drops of water falling like shot from the summit to the floor sparkle as gems, and add their music to the occasion. We tried to fancy how it would seem to have a winter cascade thunder down on the rocks where we stood. We raised and lowered at will the glowing fire-basket, bringing into view the series of immense rings, each eight or ten feet thick, that make up the wall, finding them differently tinted and some of them finely fringed with stalactitic drapery. Half the floor is covered by a pool, whose waters escape under a low ledge to regions as yet unexplored. Mention should be made of the remarkable echoes that add to the charm of this extraordinary dome.

The Pearly Pool route is entered by a tunnel sixty feet long. We pause a moment on the verge of a pit

eighty-six feet deep, around which are some curiously formed stalagmites resembling various birds and beasts. Ages ago a big stalactite fell with its tip under the drippings of a cascade, which left on it a rich nacrous incrustation. The basin, three or four feet wide, that catches these waters, is the Pearly Pool, and glistens with hundreds of cave pearls. Some nameless, graceless scamp has struck his hammer into the middle of it, thus making an outlet for the water and terminating the pearl-making business, at least for a time.

The Kangaroo Bend opens into the Snowy Valley, some six hundred feet long, where fine gypsum formations abound. This valley ends in a tumble-down where copious chalybeate springs flow over iron-stained stalagmites. The water is palatable, and it is claimed that it possesses valuable medicinal properties.

It only remains to add a few words about what will perhaps be styled the "New Discovery" until some more appropriate title shall have been found. It begins near the entrance to the cave, and has been surveyed for two thousand linear feet. So much of it has to be traversed in a stooping position, or on one's hands and knees, that its length seems at least twice that distance. Patience finds its reward as we are introduced to a region utterly unlike anything else in the vicinity, though similar places are to be seen in certain caves in Indiana.

The bed-rock is a fine-grained magnesian limestone, resembling that used for lithographic purposes. Indeed the material has been satisfactorily tested for this use since our visit. For many hundred feet the path has been artificially cut through this beautiful rock. On every hand we behold on walls and roof the most charming rosettes and intricately convoluted helictites. The

Everett Rock.

Florence Avenue.

fact that no names have as yet been given to places and formations in the "New Discovery" makes description difficult. Helictite Grotto and Rosette Chamber are so called on account of the abundance of the formations thus indicated. This part of the Colossal Cavern is a perfect flower-garden, where the excited fancy may find in unsullied loveliness a crystal reproduction of almost every floral gem. The management wisely guard these matchless decorations from spoliation; but it is also to be hoped that such a wilderness of subterranean charms may soon be made accessible (if this has not already been done), so that it may be enjoyed by the general public. Meanwhile we understand the "New Discovery" can be visited only by special arrangement with the custodians of the cave, and even then only by small parties. The general similarity and the close proximity of the Colossal and the Mammoth caves make it not at all improbable that they are connected by avenues as yet undiscovered. On the other hand, it may be that they are permanently and completely disconnected by means of such immense downfalls as the Eden Valley and the Doyle Valley, through which now runs the carriage-road between the entrances to the two caverns.

Anyhow, it is well worth while for the tourist who visits one of these vast caverns to take time to see the other also. While in many ways similar to each other, there are enough points of difference to keep the interest alive. In all ages caverns have excited the awe and admiration of mankind, and in no part of the known world are so many and such magnificent caverns clustered together as exist in Edmondson County, Kentucky. Such a marvelous region is worthy, not merely of a hurried visit, but of a leisurely sojourn.

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